JOURNAL OF CLINICAL MICROBIOLOGY, May 1997, p. 1260–1262 Vol. 35, No. 5
0095-1137/97/$04.00+0


# Food-Borne Disease Outbreaks Due to Bacteria in Taiwan, 1986 to 1995

TZU-MING PAN,[1]* TIEN-KUEI WANG,[1] CHIH-LUNG LEE,[1] SHI-WERN CHIEN,[2] AND CHI-BYI HORNG[1]

*Bacteriology Division, National Institute of Preventive Medicine, Taipei, Taiwan 11513,[1] and Bureau of Food Sanitation, Department of Health, Taipei, Taiwan 10726,[2] Republic of China*

Received 7 October 1996/Returned for modification 5 December 1996/Accepted 28 January 1997

**Between 1986 and 1995, 852 outbreaks of food-borne disease involving 26,173 cases and 20 deaths were reported in Taiwan. About 80% of the outbreaks occurred in the warmer months, i.e., between April and October. Of the 852 reported outbreaks, 555 (65%) were caused by bacterial pathogens. The three most common bacteria involved were *Vibrio parahaemolyticus* (35%, 197 of 555 outbreaks), *Staphylococcus aureus* (30%, 169 of 555 outbreaks), and *Bacillus cereus* (18%, 104 of 555 outbreaks).**

Outbreaks provide a unique opportunity to obtain information about food-borne diseases (1). Food-borne disease outbreaks have attracted attention in developed countries for a long time (7, 10–12, 15). In Taiwan, data from incidences of food-borne disease outbreaks have been collected by the Department of Health since 1981 (4). However, epidemiologic data, such as number of cases, incubation period, etiology, sources of contaminated food, and place of preparation, were systemically collected only after 1986. This paper outlines the food-borne bacterial disease outbreaks in Taiwan between 1986 and 1995 by bacterial etiology and seasonality.

Methods for cultivation and isolation of the bacterial pathogens *Vibrio parahaemolyticus* (16, 18), *Staphylococcus aureus* (13), pathogenic *Escherichia coli* (6), *Salmonella* spp. (17), and *Bacillus cereus* (14) were as described previously and elsewhere (7). Briefly, thiosulfate-citrate-bile-sucrose agar (Difco Laboratories, Detroit, Mich.) was used for the isolation and differentiation of *V. parahaemolyticus*. Suspected colonies were tested for glucose utilization (triple sugar iron agar; Difco Laboratories) and lysine decarboxylation (lysine iron agar; Difco). After these preliminary tests, biochemical tests were performed with the API 20E system (Biomerieux, Marcy l'Etoile, France), as well as growth in 0 to 10% NaCl and serologic typings for K antigens. Baird-Parker agar supplemented with Egg Yolk Tellurite Enrichment (Difco) was used for the cultivation and detection of *S. aureus*. Suspected colonies were examined by a coagulase test, a heat-stable staphylococcal nuclease test, biochemical tests with API ID 32 Staph (Biomerieux), and enterotoxin typing (Denka Seiken Co., Tokyo, Japan). MacConkey agar, sorbitol-MacConkey agar, and *Salmonella-Shigella* agar (Difco) were used for cultivation and isolation of *E. coli* and *Salmonella* spp. Suspected colonies were examined for glucose utilization and lysine decarboxylation, and biochemical tests were performed as described for *V. parahaemolyticus*. Serologic typing for O antigens and H antigens was performed for these two bacteria. Cereus selective agar (E. Merck, Darmstadt, Germany) supplemented with egg yolk and polymyxin was used for isolation of *B. cereus*. Suspected colonies were tested for β-hemolysis, and API 50CH (Biomerieux) was used for biochemical tests. *B. cereus* enterotoxin was detected by a reversed passive latex agglutination test (Denka Seiken). Laboratory procedures of the Centers for Disease Control and Prevention, Atlanta, Ga., were followed for the isolation, detection, and toxin typing of *Clostridium botulinum* (2).

The bacterial etiology of a reported outbreak was confirmed by comparison of clinical symptoms, disease incubation period, implicated foods, and laboratory findings.

Table 1 shows that from 1986 through 1995, 852 food-borne disease outbreaks were reported in Taiwan, involving 26,173 cases and 20 deaths. From 1986 to 1993, the numbers of outbreaks and cases per year fluctuated, without showing a tendency to increase. However, in the years 1994 to 1995, substantial increases in the numbers of outbreaks and cases were observed. From 1986 to 1990, the monthly median numbers of cases fluctuated, ranging from 90 to 153, but a trend toward increasing numbers has been observed since 1990.

Of the 852 outbreaks reported to the Department of Health, Taiwan, 555 (65%) were caused by bacterial agents. *V. parahaemolyticus* (35.5%), *S. aureus* (30.5%), and *B. cereus* (18.7%) accounted for most of the outbreaks with bacterial etiologies. These bacteria were involved in 38.5, 28.6, and 20.8% of cases, respectively. However, in 1994 and 1995, the numbers of outbreaks caused by *B. cereus* were almost the same as those caused by *S. aureus* (Table 1). Pathogenic *E. coli* and *Salmonella* species accounted for 36 (6.5%) and 31 (5.6%) outbreaks with bacterial etiologies, respectively. *C. botulinum* caused 10 (1.8%) outbreaks in the 10-year period. Though diarrheal disease caused by *Plesiomonas shigelloides* and *Vibrio cholerae* non-O1 is frequently found in Asia (9, 19), only a tiny portion of outbreaks (less than 1.4%) in Taiwan were caused by these organisms (Table 2).

Taiwan is a subtropical island, and 80% of food-borne disease outbreaks occurred in the warmer months, i.e., between April and October. In the numbers of all reported cases, two peaks were found, one in May and the other in October, although the number of reported cases was actually higher in September than in May. The numbers of outbreaks due to *V. parahaemolyticus* and *B. cereus* also had two peaks, one from June to July and the other in September (Table 3). A drop in the numbers of outbreaks and cases was observed each August, which may be related to the restriction of social activities for religious reasons and the closing of schools for summer vacation.

*V. parahaemolyticus* plays a leading role in food-borne disease in Taiwan (3, 18). The number of outbreaks caused by this organism has increased sharply in Taiwan since 1990. Serovar

* Corresponding author. Mailing address: Bacteriology Division, National Institute of Preventive Medicine, Taipei, Taiwan 11513, Republic of China. Phone: (886)-02-785-7556. Fax: (886)-02-786-4367. E-mail: NIPMI@tpts1.seed.net.tw.

TABLE 1. Food-borne disease outbreaks and cases in Taiwan, 1986 to 1995

| Year | Total no. of outbreaks | No. of outbreaks caused by bacterial agent[a]: | | | Total no. of cases[b] | Median no. of cases by mo |
|---|---|---|---|---|---|---|
| | | VP | SA | BC | | |
| 1986 | 62 | 7 | 4 | 3 | 1,820 | 133 |
| 1987 | 84 | 16 | 11 | 11 | 1,505 | 95 |
| 1988 | 82 | 16 | 22 | 12 | 1,949 | 90 |
| 1989 | 84 | 18 | 20 | 6 | 2,547 | 153 |
| 1990 | 57 | 2 | 22 | 8 | 1,514 | 84 |
| 1991 | 93 | 12 | 23 | 13 | 2,378 | 107 |
| 1992 | 88 | 20 | 18 | 16 | 3,084 | 130 |
| 1993 | 77 | 25 | 24 | 12 | 2,150 | 146 |
| 1994 | 102 | 35 | 13 | 12 | 4,276 | 193 |
| 1995 | 123 | 46 | 12 | 11 | 4,950 | 246 |
| Total | 852 | 197 | 169 | 104 | 26,173 | |

[a] Abbreviations: BC, *B. cereus*; SA, *S. aureus*; VP, *V. parahaemolyticus.*
[b] Including 20 deaths.

TABLE 3. Distribution of cumulative numbers of outbreaks caused by three major pathogens in Taiwan, by month, 1986 to 1995

| Mo | No. of outbreaks caused by bacterial agent[a]: | | | Total no. of outbreaks | Total no. of cases |
|---|---|---|---|---|---|
| | VP | SA | BC | | |
| January | 2 | 5 | 5 | 34 | 1,414 |
| February | 0 | 4 | 0 | 27 | 379 |
| March | 0 | 7 | 9 | 56 | 897 |
| April | 17 | 16 | 10 | 76 | 1,651 |
| May | 16 | 19 | 12 | 90 | 3,809 |
| June | 34 | 20 | 13 | 97 | 3,124 |
| July | 35 | 22 | 7 | 106 | 2,262 |
| August | 23 | 20 | 5 | 81 | 1,843 |
| September | 36 | 27 | 19 | 117 | 4,028 |
| October | 24 | 16 | 15 | 77 | 4,871 |
| November | 7 | 8 | 6 | 51 | 1,102 |
| December | 3 | 5 | 3 | 40 | 793 |
| Total | 197 | 169 | 104 | 852 | 26,173 |

[a] Abbreviations: BC, *B. cereus*; SA, *S. aureus*; VP, *V. parahaemolyticus.*

K8 was isolated most frequently in Taiwan (13) and Southeast Asia (19). In most cases, sources of outbreaks were seafoods which were supplied to elementary or junior high schools in lunch boxes or prepared by party caterers for social or religious activities. A sizeable proportion (56.7%) of outbreaks in Taiwan are still caused by this organism (13).

*S. aureus* is the next most common food-borne pathogen in Taiwan. This organism also plays an important role in food-borne disease in the United States (1). The numbers of outbreaks in Taiwan due to this bacterium were stable from 1988 to 1993, ranging from 18 to 24 annually, but dropped markedly to 12 in 1994 and 11 in 1995. In Taiwan, enterotoxin A-producing strains of *S. aureus* were the most frequently isolated during outbreaks. In 1994, 53.3% (8 of 15) of the *S. aureus* outbreaks were associated with enterotoxin A (13).

The numbers of outbreaks caused by *B. cereus* fluctuated, ranging from 3 in 1986 to 15 in 1992. In 1994 and 1995, the numbers of outbreaks caused by *B. cereus* were almost the same as those of *S. aureus* (Table 1), but the numbers were quite high compared to those of another rice-consuming country, Japan (8, 14).

Outbreaks caused by pathogenic *E. coli* and *Salmonella* species accounted for 36 (6.5%) and 31 (5.6%) of the outbreaks with bacterial etiologies, respectively. Since pathogenic *E. coli* was evaluated only after major food-borne pathogens were found to be absent from fecal specimens, the number of pathogenic *E. coli* outbreaks may be underestimated.

Outbreaks due to *Salmonella* spp. are rare in Taiwan compared to those in the United States (1, 10, 11) and Japan (8). In Taiwan, 10 *Salmonella* serovars were isolated most frequently from 1983 to 1993 (17). Among them, *Salmonella typhimurium* was the leading serovar, but *Salmonella virchow* also played a major role in large outbreaks. In recent years, *Salmonella enteritidis* has emerged as a new serovar in Taiwan.

*C. botulinum* caused 10 outbreaks from 1986 to 1990. However, no outbreak of *C. botulinum* has been detected since 1991. In these 10 outbreaks, botulinal A, B, and E toxin-producing strains were found at frequencies of 30, 60, and 10%, respectively.

Reporting diarrheal disease due to *Shigella* infection is obligatory in Taiwan (5). From 1988 to 1995, a total of 1,185 cases were found. Most cases of shigellosis were caused by *Shigella flexneri* (33.5%) and *Shigella sonnei* (65.7%). From 1986 through 1992, 35% of annual outbreaks were classified as being of unknown etiology. Laboratory technicians and epidemiologic personnel should be more aware of other pathogens which are not included in this study.

TABLE 2. Outbreaks and cases of food-borne disease of bacterial etiology in Taiwan, 1986 to 1995

| Bacterial etiology | No. (%) of outbreaks | No. (%) of cases |
|---|---|---|
| *V. parahaemolyticus* | 197 (35.5) | 8,967 (38.5) |
| *S. aureus* | 169 (30.5) | 6,651 (28.6) |
| *B. cereus* | 104 (18.7) | 4,844 (20.8) |
| *E. coli* | 36 (6.5) | 1,391 (6.0) |
| *Salmonella* spp. | 31 (5.6) | 1,038 (4.5) |
| *C. botulinum* | 10 (1.8) | 19 (<0.1) |
| Other[a] | 8 (1.4) | 360 (1.5) |
| Total | 555 (100) | 23,270 (100) |

[a] *V. cholerae* non-O1, *P. shigelloides*, and *Aeromonas hydrophila.*

This work was supported in part by a grant from the Department of Health, Taiwan (DOH85-TD-002).

We thank Shiou-Ing Chiu, Hsiao-Ling Yea, Jin-Lai Tsai, and Yueong-Sheng Lee for technical assistance, Su-Ching Chiang for editorial assistance, and Kwo-Tong Chen for a critical review of the manuscript.

## REFERENCES

1. **Bean, N. H., and P. M. Griffin.** 1990. Foodborne disease outbreaks in the United States, 1973–1987. J. Food Prot. **35:**804–817.
2. **Centers for Disease Control.** 1979. Botulism in the United States, 1899–1977, p. 8–12. *In* R. A. Gunn (ed.), Handbook for epidemiologists, clinicians, and laboratory workers. U.S. Department of Health, Education, and Welfare, Atlanta, Ga.
3. **Chiang, T. S., T. M. Pan, and K. T. Chen.** 1996. A large-scale *V. parahaemolyticus* food poisoning outbreak. Epidemiol. Bull. (Department of Health, Taiwan, Republic of China) **12:**145–157.
4. **Chiou, A., and S. K. Chen.** 1991. Food-borne illness in Taiwan, 1981–1989. Food Aust. **54:**70–71.
5. **Department of Health, Taiwan, Republic of China.** 1995. Cases of notifiable and reportable disease, Taiwan-Fukien area, November 1995. Epidemiol. Bull. (Department of Health, Taiwan, Republic of China) **11:**195–197.
6. **Farmer, J. J., and M. T. Kelly.** 1991. *Enterobacteriaceae*, p. 360–370. *In* A. Balows, W. J. Hausler, K. L. Herrmann, H. D. Isenberg, and H. J. Shadomy (ed.), Manual of clinical microbiology, 5th ed. American Society for Microbiology, Washington, D.C.
7. **Finegold, S. M., and W. J. Martin.** 1982. Cultivation of pathogenic microorganisms from clinical material, p. 81–91. *In* Bailey and Scott's diagnostic microbiology, 6th ed. C. V. Mosby Co., St. Louis, Mo.

8. **Food Sanitation Division, Ministry of Health and Welfare, Tokyo, Japan.** 1995. The epidemiological data of food poisoning in 1994. Food Sanit. Res. **45:**77–104. (In Japanese.)
9. **Kodama, H., and H. M. Gyobu.** 1991. Surveys on the contamination of marine fish with non-O1 *V. cholerae* and *V. mimicus* and food poisoning cases by these organisms. J. Jpn. Assoc. Infect. Dis. **65:**193–199.
10. **Levine, W. C., J. F. Smart, D. L. Archer, N. H. Bean, and R. V. Tauxe.** 1991. Food-borne disease outbreaks in nursing homes, 1975 through 1987. JAMA **266:**2105–2109.
11. **Mishu, B., J. Koehler, L. A. Lee, D. Rodrigue, F. H. Brenner, P. Blake, and R. V. Tauxe.** 1994. Outbreaks of *Salmonella enteritidis* infections in the United States, 1985–1991. J. Infect. Dis. **169:**547–552.
12. **Notermans, S., and A. Hoogenboom-Verdegaal.** 1992. Existing and emerging food-borne diseases. Int. J. Food Microbiol. **15:**197–205.
13. **Pan, T. M., C. S. Chiou, S. Y. Hsu, H. C. Huang, T. K. Wang, S. I. Chiu, H. L. Yea, and C. L. Lee.** 1996. Food-borne disease outbreaks in Taiwan, 1994. J. Formosan Med. Assoc. **95:**417–420.
14. **Shinagawa, K.** 1990. Analytical methods for *Bacillus cereus* and other *Bacillus* species. Int. J. Food Microbiol. **10:**125–141.
15. **Sockett, P. N., J. M. Cowden, S. L. Baigue, D. Ross, G. J. Adak, and H. Evans.** 1993. Foodborne disease surveillance in England and Wales: 1989–1991. Communicable Dis. Rep. Rev. **3:**R159–R173.
16. **Twedt, R. M.** 1989. *Vibrio parahaemolyticus*, p. 543–568. *In* M. P. Doyle (ed.), Food-borne bacterial pathogens. Marcel Dekker, Inc., New York, N.Y.
17. **Wang, T. K., T. C. Tseng, J. H. Lee, W. T. Wang, J. L. Tsai, S. I. Ho, and T. M. Pan.** 1994. Analysis of *Salmonella* serovars in Taiwan by the phase induction method. Chin. J. Microbiol. Immunol. (Taipei) **27:**13–24.
18. **Wong, H. C., S. H. Ting, and W. R. Shieh.** 1992. Incidence of toxigenic *Vibrio* in foods available in Taiwan. J. Appl. Bacteriol. **73:**197–202.
19. **Yosida, A., K. Noda, K. Omura, K. Miyagi, H. Mori, N. Suzuki, S. Takai, Y. Matsumoto, K. Hayashi, and Y. Miyata.** 1992. Bacteriological study of traveller's diarrhea. J. Jpn. Assoc. Infect. Dis. **66:**1422–1435.