

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

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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 aggluti-

nation 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

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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.

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 com-

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
<i>V. parahaemolyticus</i>	197 (35.5)	8,967 (38.5)
<i>S. aureus</i>	169 (30.5)	6,651 (28.6)
<i>B. cereus</i>	104 (18.7)	4,844 (20.8)
<i>E. coli</i>	36 (6.5)	1,391 (6.0)
<i>Salmonella</i> spp.	31 (5.6)	1,038 (4.5)
<i>C. botulinum</i>	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*.

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*.

pared 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, botulinum 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.

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