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An outbreak of *Salmonella* infection after a Chinese year-end party in central Taiwan

Kai-Lin Hwang, Tzuu-Guang Young[1], Nan-Ying Chiu[2], Huey-Ching Horng[3], Min-Kai Kou[4]

Department of Medical Research, [1]Division of Infectious Diseases, [2]Departments of Psychiatry and [3]Laboratory, Changhua Christian Hospital, Changhua, and [4]Health Bureau of Taichung City, Taichung, Taiwan, ROC

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An outbreak of food poisoning caused by *Salmonella* O7 serogroup C_1 and O8 serogroup C_2, occurred in Taichung City after a Chinese year-end buffet party with 127 attendees including employees, relatives and guests of the Psychiatry Department of Changhua Christian Hospital (CCH). Among the 114 attendees interviewed, 96 (84.2%) reported developing symptoms within 120 h after the dinner on February 4, 1999. The time of onset ranged from 2 h to 101 h after the dinner with an average of 20 ±16 h. The median and mode incubation periods were 17 h and 16 h, respectively. *Salmonella* C_1 and C_2 serogroups were isolated from the stool samples of 45 attendees. Based on the results of interview questionnaire, the most likely contaminated food was eel kabayaki (OR = 4.8, 95% CI:1.6-14.9, $p < 0.01$) followed by baked mussels (OR = 4.04, 95% CI:1.3-12.1, $p = 0.01$). However, this result could not be confirmed by food sample investigation due to the lack of leftover food. Possible techniques for the prevention of food-borne disease transmission, enhancement of communication about food-borne disease outbreaks within the health reporting system, and the reduction of response time during an outbreak of infection are required.

Key words: *Salmonella*, outbreak, Taiwan

Salmonella, a member of the Enterobacteriaceae family, is a genus of gram negative, nonspore-forming, usually motile, facultative anaerobic bacilli [1]. The digestive tract, particularly the cecum, is the principal site of multiplication of these bacteria in humans, which may cause widespread contamination of the environment [2]. Diarrhea, fever, abdominal cramps, vomiting, nausea, chills and headache are the predominant symptoms of *Salmonella* infection. The incubation period ranges from 2 h to 72 h. However, cases with symptoms beginning 106 h to 120 h after the consumption of contaminated food have also been reported. The illness usually resolves in 5 to 7 days without treatment unless the patient becomes dehydrated or the infection spreads outside of the intestine. Most cases of serious illness and death associated with salmonellosis occur among infants, the elderly, and immunocompromised persons [3-5].

The incidence of food poisoning due to *Salmonella* has increased dramatically over the past decade in many countries, including the United States, Japan, Thailand, and Brazil [6-10]. Some phage types have been dominant in certain regions. For example, *Salmonella enteritidis* PT4 is very common in the United Kingdom, while PT34 was isolated from several outbreaks in Japan [11,12]. Sporadic cases and outbreaks all over the world have been linked to homemade foods, industrial and agricultural products, institutional meals, domestic catering, bakeries, and restaurants. Meat, poultry, raw eggs and their products are the most commonly implicated vehicles of infection; however, other types of food, such as grains, vegetables, milk, dairy products, fish and shellfish have also been reported [13-16]. Inappropriate storage, inadequate heat treatment, cross contamination, and infected food handlers have been cited as possible sources of transmission among food-borne outbreaks worldwide [13, 14].

A total of 19 outbreaks of *Salmonella* food poisoning were reported to the Department of Health (DOH), ROC, during the period from 1994-1997. Among the 10 serotypes isolated, *Salmonella enteritidis* caused six outbreaks (total of 174 people affected), *Salmonella montevideo* caused three outbreaks (total of 32 people affected), *Salmonella weltevreden* and

Corresponding author: Dr. Kai-Lin Hwang, Department of Medical Research, 135 Nanhsiao Street, Changhua Christian Hospital, Changhua 500, Taiwan, ROC.

Table 1. Demographic characteristics of the party attendees

	Symptomatic					
	Yes		No		Overall	
	No. of cases	%	No. of cases	%	No. of cases	%
Total	96	100	18	100	114	100
Age (year)						
<18	9	9.4	5	27.8	14	12.3
≥18	87	90.6	13	72.2	100	87.7
Sex						
Male	42	43.8	6	33.3	48	42.1
Female	54	56.2	12	66.7	66	57.9

Salmonella virchow caused two outbreaks each (total of 18 and 9 people affected, respectively), and each of the other six serotypes caused one event each with a total of 73 people affected. Summer was the most common season for transmission [17].

The Psychiatry Department of Changhua Christian Hospital (CCH) had a year-end party at a famous restaurant in Taichung City on the evening of February 4, 1999. A buffet meal was served for dinner, including two kinds of soup, cold and hot dishes, salad bar, assorted breads, desserts, and beverages. A few hours later, several attendees visited the CCH Emergency Department due to vomiting, diarrhea and other symptoms of food poisoning, and a total of 49 people were treated during the following 3 days. Two other groups who ate meals at the same restaurant in the preceding 2 days also reported food poisoning events. The CCH and Health Bureau of Taichung City therefore conducted an investigation of the cause of the outbreak.

Materials and Methods

During the period from February 8 to 12, 1999, a structured, self-administered questionnaire was distributed to employees, guests and family members who had attended the dinner party on February 4, 1999. Data collected included demographic characteristics, time of onset of symptoms, specific symptoms, and food eaten during the dinner. Some of the CCH party attendees were personally interviewed by investigators from the DOH using an almost identical questionnaire and the data from these interviews were also included in the analysis. A stool specimen was collected from all of the people who had visited the CCH Emergency Department during the outbreak. Food samples from the restaurant were collected on February 6, 1999 and examined by investigators from the Health Bureau of Taichung City. Bacterial culture testing was performed on both human and food samples. The serological differentiation of *Salmonella* was performed using commercial kit (*Salmonella* Grouping Antisera by BBL Microbiology Systems company) and the Kauffmann-White Scheme was used to identify the serogroup of

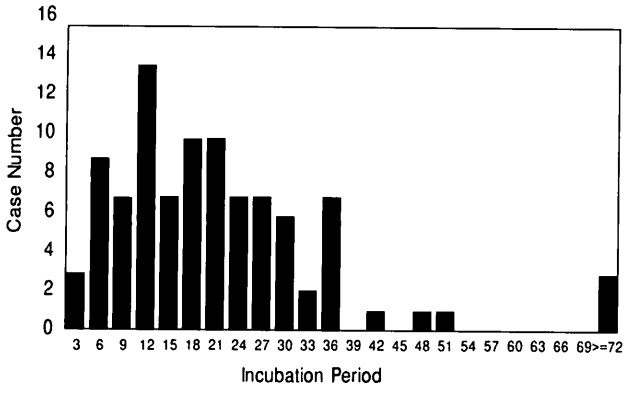

Fig. 1. The onset time post the party (n = 95).

Table 2. Frequency of symptoms reported by the 96 symptomatic subjects

	No. of cases	%
Fever	69	71.9
Chills	66	68.8
Nausea	36	37.5
Vomiting	25	26.0
Dizziness/headache	68	70.8
Abdominal extension	35	36.5
Diarrhea	85	88.5
Abdominal pain	66	68.8
Weakness	50	52.1
Constipation	4	4.2
Blood in stool	3	3.1
Body soreness	28	29.2
Nasal dripping	2	2.1
Cough	5	5.2
Ear pain	1	1.0
Lip vesicle	2	2.1

Table 3. Attack rates and age-sex-adjusted odds ratios for each of the foods eaten by attendees

	Ate			Did not eat			OR	95% C.I.	*p*
	No.of cases	Sick	%	No. of cases	Sick	%			
Seafood with creamy soup	37	29	78.4	74	64	86.5	0.63	0.22 - 1.79	0.39
Borsch soup	33	29	87.9	78	64	82.1	1.37	0.40 - 4.68	0.61
Smoked devilfish	45	39	86.7	66	54	81.8	1.43	0.49 - 4.18	0.51
Assorted sashimi	40	34	85.0	71	59	83.1	0.92	0.30 - 2.84	0.89
Eel kabayaki	65	60	92.3	46	33	71.7	4.80	1.55 - 14.90	< 0.01
Macaroni salad	23	21	91.3	88	72	81.8	2.53	0.53 - 12.16	0.25
Assorted sushi	53	43	81.1	58	50	86.2	0.72	0.26 - 2.02	0.54
Pork jelly	28	23	82.1	83	70	84.3	0.73	0.23 - 2.34	0.60
Smoked fish	30	26	86.7	81	67	82.7	1.26	0.37 - 4.24	0.71
Marinated goose in wine	53	46	86.8	58	47	81.0	1.49	0.53 - 4.23	0.45
Jellyfish with celery	34	32	94.1	77	61	79.2	4.14	0.89 - 19.29	0.07
Mutton aspic	35	33	94.3	76	60	78.9	3.92	0.83 - 18.43	0.08
Sweetened cashew nuts	35	29	82.9	76	64	84.2	0.81	0.27 - 2.44	0.71
Fried black mushrooms	57	47	82.5	54	46	85.2	0.86	0.31 - 2.41	0.77
French fries	34	27	79.4	77	66	85.7	0.63	0.22 - 1.84	0.40
Tomato/celery	32	28	87.5	79	65	82.3	1.44	0.43 - 4.81	0.56
Cucumber/carrots	13	107	6.9	98	83	84.7	0.50	0.12 - 2.14	0.35
Lettuce/corn	23	17	73.9	88	76	86.4	0.44	0.14 - 1.37	0.16
Bean sprouts	11	8	72.7	100	85	85.0	0.39	0.09 - 1.76	0.22
Thousand island dressing	20	17	85.0	91	76	83.5	0.98	0.25 - 3.87	0.97
Peanut sour sauce	4	3	75.0	107	90	84.1	0.49	0.05 - 5.11	0.55
Prawns with coconut cream	74	64	86.5	37	29	78.4	1.61	0.56 - 4.63	0.38
Sauteed crab with cinnamon	44	39	88.6	67	54	80.6	1.74	0.56 - 5.36	0.34
Braised spareribs	41	35	85.4	70	58	82.9	1.17	0.40 - 3.43	0.78
Baked mussels	70	64	91.4	41	29	70.7	4.04	1.34 - 12.14	0.01
Steamed cod	47	39	83.0	64	54	84.4	0.87	0.31 - 2.44	0.79
Lam cutlets	61	51	83.6	50	42	84.0	0.84	0.29 - 2.39	0.74
Braised mushroom and bamboo shoots	30	24	80.0	81	69	85.2	0.70	0.23 - 2.14	0.54
Sauteed vegetables	20	15	75.0	91	78	85.7	0.45	0.14 - 1.51	0.20
Fried rice	59	51	86.4	52	42	80.8	1.38	0.49 - 3.88	0.55
Rice noodles	38	34	89.5	68	55	80.9	2.08	0.62 - 6.99	0.23
Short cake	15	11	73.3	96	82	85.4	0.43	0.12 - 1.57	0.20
Smashed lotus cake	15	12	80.0	96	81	84.4	0.63	0.15 - 2.60	0.52
Smashed date sponge cake	15	12	80.0	96	81	84.4	0.59	0.14 - 2.47	0.47
French pastries	53	43	81.1	58	50	86.2	0.82	0.29 - 2.36	0.72
Assorted fruit jelly	28	24	85.7	83	69	83.1	1.17	0.35 - 3.95	0.80
Fruit platter	62	51	82.3	49	42	85.7	0.73	0.26 - 2.06	0.55
Coffee	27	21	77.8	82	70	85.4	0.54	0.18 - 1.66	0.28
Black tea	26	22	84.6	85	71	83.5	0.99	0.29 - 3.38	0.99
Cocktail	81	66	81.5	30	27	90.0	0.48	0.13 - 1.86	0.29

the pathogen [18,19]. According to the presence of somatic (O) antigens, *Salmonella* isolates can be classified into group A, B, C_1, C_2, D and E.

An epidemic curve was constructed to illustrate the incubation period. The median and mean incubation period and the duration of illness were calculated. Attack rates and odds ratios with 95% confidence intervals for each specific dish were estimated and compared between the groups with and without symptoms using logistic regression analysis, adjusting for age and gender effects.

Results

A total of 114 completed questionnaires were collected among the 127 distributed, and 96 (84.2%) of these subjects reported that symptoms had occurred within 120 h after the dinner on February 4, 1999. Among the 114 subjects who completed the questionnaire, 48 (42%) were male and 14 (12.3%) were younger than 18 years of age (Table 1). The age and gender distributions were not significantly different between groups with and without symptoms, except that the symptomatic

subgroup had a smaller percentage (9.4%) of children under 18 years of age than the asymptomatic subgroup (27.8%) ($p = 0.045$ by Fisher's exact test). The time of onset ranged from 2.4 h to 101 h after the dinner with an average of 20.36 ±16.08 h. The median and mode incubation periods were 17 h and 16 h, respectively (Fig. 1). About 97% (92/95) of subjects had symptoms within 48 h after the dinner, and the other three individuals had onset times of 75 h, 86 h and 101 h, respectively. There was one symptomatic subject who did not record the time of onset. The most common symptoms were diarrhea (88.5%), fever (71.9%), dizziness and/or headache (70.8%), chills (68.8%), abdominal cramps (68.8%) and weakness (52.1%). Other symptoms including nausea, abdominal distension, vomiting, body soreness, etc., were also reported (Table 2). Among the subjects who visited the CCH Emergency Department due to food poisoning symptoms, *Salmonella* O7 serogroup C_1 was isolated in stool samples of 43 patients, *Salmonella* O8 serogroup C_2 in one patient, and both serotypes in one patient. The duration of illness lasted from 1 h to 245 h with average and median times of 104.3 h (±53.5 h) and 96 h, respectively. The duration of illness was not significantly correlated with age, gender or time of onset.

Table 3 summarizes the attack rates and the age-sex-adjusted odd ratios for the various foods eaten during the dinner. Eel kabayaki (OR = 4.8, 95% CI: 1.6-14.9, $p < 0.01$) and baked mussels (OR = 4.04, 95% CI:1.3-12.1, $p = 0.01$) were the most suspicious dishes among the 50 dishes served. Among the 44 subjects who ate both dishes, 42 (95.5%) had symptoms, and the age-sex-adjusted OR was 14.6 compared to those who did not consume either one of these dishes. No significant interaction between the two dishes was observed. Jellyfish with celery (OR = 4.1, $p = 0.07$) and mutton aspic (OR = 3.9, $p = 0.08$) were also possible infection sources with borderline significance. No leftover food from the party was available by the time the investigators of the Taichung Health Bureau performed the inspection. A total of 28 food samples were collected from the same restaurant on February 6, 1999, and *E.coli* O18 was identified in four different dishes: chicken, vegetarian goose, brown rice, and crab meat.

Discussion

Poor temperature control during preparation, cooking and storage of food is the major factor contributing to food-borne outbreaks [13]. The weather in Taichung at the time of this outbreak was humid and unseasonably warm for February. The outbreak occurred during the traditional week for the Chinese lunar year-end party, in which companies and organizations treat their employees at restaurants, and many restaurants had been fully booked weeks before the event. Among the four foods suspected of transmitting *Salmonella* infection, three were cold dishes. It was very likely that the restaurant had prepared the food, especially the cold dishes, early in the afternoon or even the day before the party, and then kept them in the refrigerator or at room temperature before serving. Although most of the Chinese food was well cooked, cross contamination after cooking was still possible. The occurrence of outbreaks on 3 consecutive days indicates that the food processing and storage procedures of the restaurant were likely to have played a key role in the outbreak.

Many types of animals can harbor *Salmonella*, including poultry, cattle and pigs. Infected humans are also capable of transmitting the pathogen. Commonly contaminated food types include raw eggs, poultry and meat, but all foods, including vegetables may become contaminated. Because chickens with lifelong *Salmonella enteritidis* ovarian infection appear healthy, it is necessary to consider the possibility that apparently healthy animals may harbor bacterial infection including *Salmonella* [20]. Vaccination of hens with an avirulent strain of *Salmonella* typhimurium has been shown to effectively protect chickens against the *Salmonella* infection, which, in consequence, may help control the *Salmonella* associated food poisoning caused by *Salmonella* in eggs [21]. In the present outbreak, although three of the four suspected dishes were seafood and the other one was mutton, in the absence of confirmation from the leftover samples, we were unable to exclude eggs, poultry and other meat as possible infectious sources. Whether the food was cross contaminated during the processes of storage and preparation after cooking, or the *Salmonella* $O7C_1$/ $O8C_2$ outbreak was transmitted through uncommon vehicles, i.e. seafood and/or mutton, remains unclear. To reduce the risk of *Salmonella* infection, it is advised to cook foods thoroughly, avoid raw eggs, and wash hands, surfaces and equipment after touching raw meat or poultry. Keeping food adequately refrigerated can prevent the bacteria present in the food from multiplying. Any food should be consumed promptly and not be held in the temperature range from 10 °C to 37 °C for more than 2 h.

When a person ingests contaminated food, the *Salmonella* bacteria take up residence in the small intestine. The onset of symptoms typically occurs from 8 h to 72 h after ingestion. The most common symptoms

are nausea, vomiting, abdominal cramps, diarrhea, fever and headache. Treatment is not usually necessary unless the infection spreads outside of the intestines or the patient becomes dehydrated. However, Salmonellosis can still be life-threatening to infants, the elderly and immunocompromised individuals. Resistance to antibiotic therapy for the *Salmonella* infection has been reported, and is thought to be a result of the large scale use of antibiotics to promote the growth of feed animals [22]. Changes in demographic characteristics, human behavior, industry, technology, the shift toward a global economy, microbial adaptation and breakdown in the public health infrastructure have driven the emergence of food-borne disease [23]. Timing is always the key-factor in isolating the infection source of a food poisoning outbreak, and in preventing the contaminated food and infected people from spreading the pathogens. A more sensitive and rapid surveillance system at local, national and international levels, including enhanced methods for laboratory identification and subtyping, and effective prevention and control strategies are essential to achieve these goals. Several international programs, such as Salm-Net, encourage a rapid alert and response co-ordination in cases of *Salmonella* outbreak [13].

Due to limited resources, our current surveillance system is mostly based on passive reporting mechanisms and laboratory isolation data derived from the specimens of infected individuals. This can result in delays of several days before investigators are able to respond to reported events, especially when reports of infection occur in more than just one district area. Failure to identify the contaminated food source makes the control and prevention of food-borne disease even more difficult. There is an urgent need to shorten the communication and response window for food poisoning outbreaks in our health reporting system. In addition, increasing the frequency and thoroughness of food safety inspections, expanding food safety research, training and educating the public and food providers are also important in preventing future food-borne outbreaks.

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