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13 Investigating a Food Poisoning Outbreak in a School
23 Cases of Notifiable and Reportable Diseases, Taiwan-Fukien Area

Investigating a Food Poisoning Outbreak in a School

1. Introduction

Vibrio parahaemolyticus is a Gram-negative, halophilous bacterium surviving under an optimum temperature of 37°C. The vibrio divides and multiplies rapidly, at about once every 8 to 12 minutes. Foods contaminated by even a small amount of *Vibrio parahaemolyticus*, at room temperature and in a salty environment, can very soon become pathogenic[1,2]. All around the world in sea water and in the mud at the bottom of the sea, in spring and in summer, the bacteria attach themselves to shellfish. Food poisoning may then occur if shellfish are eaten raw or insufficiently cooked[2]. Cases of food poisoning induced by vegetables contaminated indirectly by previously used knives, chopping boards, dish cloths, utensils, containers and fingers have also been reported[1-3].

The incubation period of *Vibrio parahaemolyticus* ranges from 2 to 48 hours, averaging 15 to 17 hours. The time of onset ranges from one to five days, averaging two days, and occurring with symptoms similar to those of Salmonellosis and Shigellosis. Some 95% of all patients will develop diarrhea and abdominal pain, plus one of the following: fever, headache, nausea or vomiting. Some may discharge bloody stools. Death, however, rarely occurs from this cause[4].

Food poisoning induced by *Vibrio parahaemolyticus* is found all around the world. More than 60% of the food poisonings in Japan are induced by this bacterium, and are considered to be related to Japanese fondness for raw fish and shellfish[5]. In the period between 1981 and 1988, a total of 333 cases of enteritis induced by *Vibrio parahaemolyticus*, primarily traceable to such sea foods as crabs, was reported in Florida, USA. Statistics for Taiwan in the period between 1981 and 1993 show that, of a total of 937 food poisoning cases, 444 (47.4%) were induced by *Vibrio parahaemolyticus*, ranking it first as a cause of such cases. Instances in Taiwan occur more frequently in warm weather, between May and November[1].

2. Background

A food poisoning outbreak in a school was reported on 25 August 1994. Around

1,000 students and teachers and staffs had had meals together on that day. After lunch, at about 5 pm of the same day, some 300 students became ill; complains were of abdominal pain, diarrhea, fever, headache, nausea, vomiting and some bloody stool. As the incident occurred in a boarding school, and affected many students, an investigation was asked for to prevent any similar future incidents.

At the time of outbreak, there were around 800 boarders in the school; all except a few were males; there were also 200 teachers and staff members. On every Wednesday evening and on the weekends, students were permitted to stay and to eat off-campus. Otherwise, all three meals were served to them in the school. Teachers and staff members could also be provided with meals, although most ate lunches only there. Two dining rooms, one for students and one for teachers, were both served by the same kitchen. The outbreak occurred on 24 August, a Wednesday, most students had had breakfast and lunch in school, but only a few stayed on for dinner. At about 5 pm, many students developed the symptoms. By 25 August, around 200 students and some teachers had been referred to hospitals for treatment.

3. Materials and Methods

1) Target population for investigation: all students, teachers, staff members and kitchen staff, a total of around 1,000 persons.

2) Tools for investigation: a structured, self-administered questionnaire containing questions regarding age, gender occupation, symptoms with time of onset, medical care sought or received, time of recovery, foods eaten at 23 August and at 24 August breakfast and lunch.

3) Definition of "case": a case was defined as anyone (including the kitchen staff) who had had meals in the school, had developed, between the dates of 24 and 26 August, diarrhea and at least one of the following symptoms: nausea, vomiting, headache, abdominal pain, fever and bloody stool.

4) Laboratory testings: rectal swabs were collected by Taipei City's Department of Public Health and sent to the National Institute of Preventive Medicine of the Department of Health for testing for *Vibrio parahaemolyticus, Bacillus cactus, Salmonella, Staphylococcus aureus, Campylobacter jejuni, Vibrio cholerase, typhoid* and *paratyphoid bacillus.*

5) Investigation of environment: sanitary conditions, drinking water, disposal of waste water, the kitchen, sources of foods and their storage, utensils, flow of food service, management of kitchen staff.

6) Data analysis: by EPI-INFO and SAS.

4. Findings

Of 700 copies of the questionnaire distributed, 583 (83.3%) were returned, and,

of those, 561 were useable for analysis.

1) Demographic characteristics:

Three hundred and four persons (54.2%) met the criteria of a case, 302 (99.3%) were males and 2 (0.07%), females; 283 (93.1%) were students, with an attack rate of 60.5%; 21 (6.9%) teachers and staff members had an attack rate of 22.6%. The average age was 35.5 years (Table 1).

Table 1. Characteristics of Cases and Attack Rate

Variables	Ill No.	Not Ill No.	Attack Rate %	p-Value
Age:				
30 and less	16	10	61.5	
31-40	253	186	57.6	0.077
40 and above	32	56	36.4	
Unknown	3	5	37.5	
Gender:				
Male	302	251	54.6	0.371
Female	2	2	50.0	
Occupation:				
Student	283	185	60.5	
Teacher	21	72	22.6	<0.001

2) Distribution of symptoms:

Three hundred and four persons (54.2%) had diarrhea; 226 (40.3%) abdominal pain; 129 (23.0%) headache; 114 (20.3) nausea; 84 (15.0%) vomiting; 9 (1.9%) bloody stool. Of these 50.6% were hospitalized, although most recovered within two to three days (Table 2).

3) Attack rate and relative odds ratio by meal:

A single variable analysis, using a simple logistic regression, of the 23 August dinner and the breakfast plus lunch on 24th August showed significant differences between results from the dinner and the breakfast ($p<0.05$). The attack rate for those who had

Table 2. Distribution of Symptoms among 561 Cases

Symptoms	No.	%
Diarrhea	304	54.2
Abdominal pain	226	40.3
Fever	129	23.0
Nausea	114	20.3
Vomiting	84	15.0
Bloody stool	9	1.6

Table 3. Logistic Regression Analysis of Illness by Meal

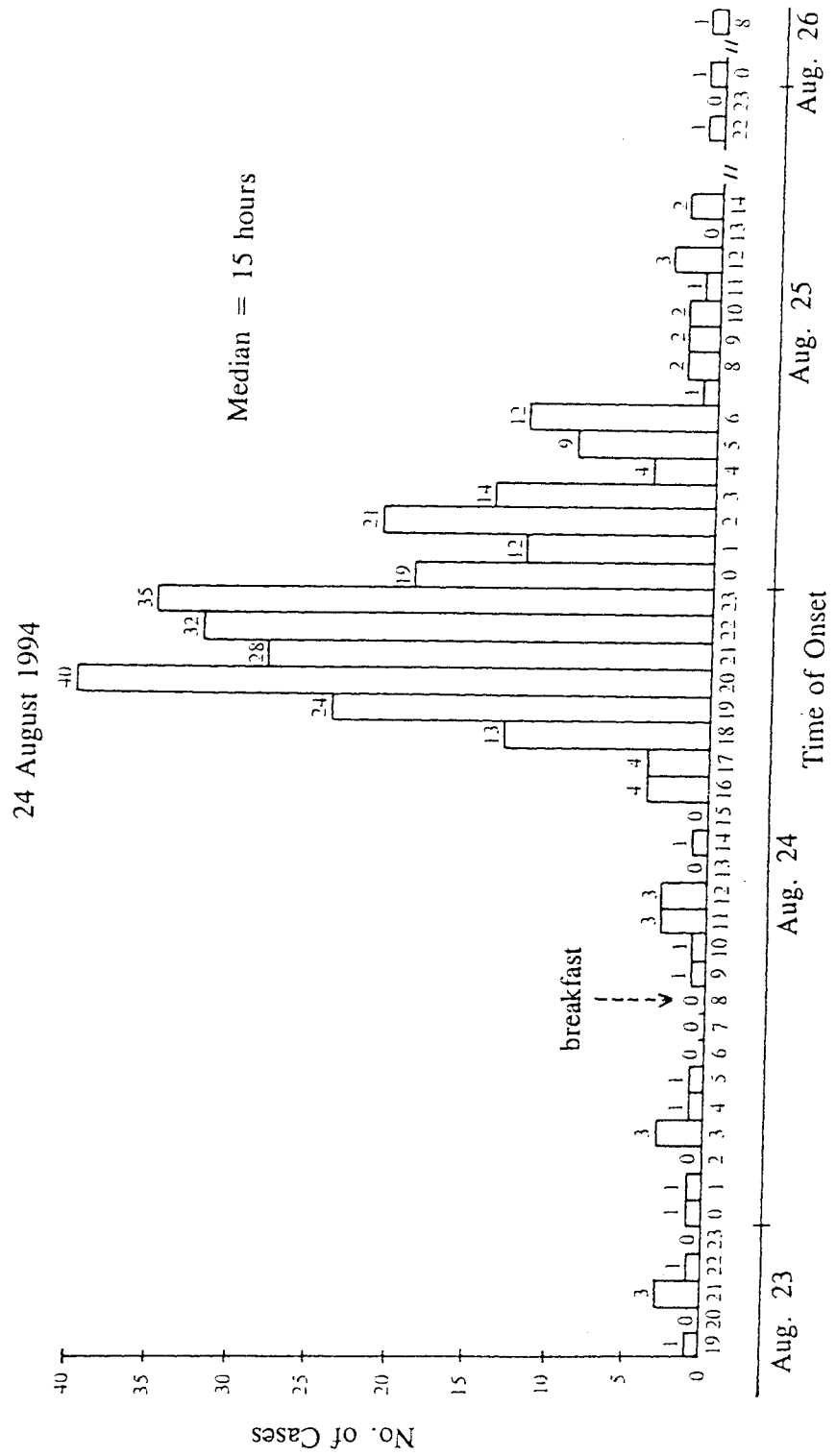
Meal	Coefficient	Standard Error	p-Value	Sample No.	OR	95% CI
Single Variable:						
Dinner-23/8	1.39	0.219	0.0001	561	4.01	2.61-6.17
Breakfast-24/8	2.67	0.303	0.0001	556	14.44	7.97-26.15
Lunch-24/8	0.65	0.442	0.1390	556	1.92	0.81-4.56
Multiple Variables:						
Dinner-23/8	0.52	0.268	0.0520	561	1.68	0.99-2.84
Breakfast-24/8	2.50	0.326	0.0001	556	12.13	6.40-22.99
Lunch-24/8	−0.30	0.550	0.5500	556	0.72	0.24-2.11

had breakfast on 24th was 14.44 times greater, and the attack rate for those who had had dinner on the 23rd was 4.01 times more than those who had not eaten (Table 3). To avoid any interference between these two meals, a multiple logistic regression analysis was also conducted. The breakfast on 24 August was found to be significant (OR = 12.13, $p<0.05$) (Table 3).

4) Epidemiological distribution:

Starting at 7 pm on 23 August, some cases developed symptoms; the outbreak began at 4 pm on 24 August, and peaked at 8 pm, continuing until 8 am on 26 August

Figure 1. Distribution of Time of Onset for 304 Food Poisoning Cases



(Figure 1). Given the time of exposure as 7 am on 24 August, the shortest incubation period was 2 hours, the longest, 49 hours; the median was 15 hours, and the mode, 13 hours.

5) Analysis of risk factors:

Analysis of the attack rate from food taken at breakfast on 24 August found that salted peanuts (OR = 14.34) and celery cooked with sliced dried bean curd (hereafter referred to as "celery") (OR = 3.88) were highly related (Table 5). To avoid any interference between the two food items, a stratified analysis was further applied for attack rates and relative odds ratios. Only the salted peanuts were related to the food poisoning, with an attack rate of 46.4%, and the odds ratio, 3.58 (Table 6).

6) Investigation of the environment:

(1) The school kitchen is connected to the dining rooms. The environment in the kitchen was clean, and the sewers were well kept. No rats nor cockroaches were found. The floor was slightly slippery.

(2) Drinking water came from tap, and was then pumped up to a water tower for use by all students and teachers. Water quality is tested every three months, although no test had done since the last typhoon (water samples had been sent to the Tri-Service General Hospital for testing after the incident).

(3) Raw and cooked foods were kept separately and under sanitary conditions. Knives and chopping boards were also separated. Freezer temperatures were maintained at lower than 5°C and different freezers were used for different meats. However, raw foods and cooked foods were not stored separately, and freezers seemed to be overloaded.

(4) Foods for both students and teachers were served from the same kitchen. Foods were supplied regularly by one dealer.

(5) An automatic dish washer was used and dishes were then placed in a high-temperature sterilizer for disinfection.

(6) Foods were served, cafeteria-style, by kitchen staff at 6:50 to 7:50 for breakfast, and 11:30 to 12:30 for teachers and 12:30 for students for lunch. Both students and teachers carried their own meals to the respective dining rooms where they ate.

(7) After being cooked, foods were not kept warm nor refrigerated before serving. Instead, they were placed, covered on tables.

(8) The 22 members of the kitchen staff were all found to be in good health, without any wounds on their hands.

Table 4. Attack Rate and Relative Odds Ratio (OR) by Dining Room for Breakfast

Dining Room	Ill No.	Not Ill No.	Attack Rate %	OR	95% CI
did not eaten	17	105	13.9	1.0	
ate:					
students'	267	141	65.4	4.71	3.14-7.65
teachers'	18	11	62.1	4.43	2.81-7.60

Table 5. Food-Specific Relative Odds Ratio (OR) on 24 August Breakfast (N = 439)

Food	Sample No.	OR	95% CI	p-Value
Rice water	333	0.9333	0.36-2.42	0.0136
Soybean milk	336	1.2020	0.47-3.07	0.8879
Chinese bread	348	0.7189	0.28-1.80	0.6998
Steamed bread	271	0.7334	0.32-1.69	0.4682
Gluten	344	0.8737	0.33-2.31	0.7864
Celery	348	3.8806	1.38-10.92	0.0102
Peanuts	381	14.3390	3.51-58.57	0.0002
Boiled egg	391	0.6294	0.14-2.73	0.5361
Vegetables	226	1.0090	0.36-2.80	0.9866

Table 6. Relative Risks (RR) Taken Peanuts and/or Celery for Breakfast

Peanuts	Celery	Sample No.	Ill No.	Not Ill No.	Attack Rate %	RR	95% CI
−	−	131	17	114	13.0	1.00	
−	+	7	2	5	28.6	2.20	0.63-7.70
+	−	28	13	15	46.4	3.58	1.96-6.49
+	+	303	230	73	75.9	5.85	3.74-9.15

Note: "+" for eaten; "−" for not eaten.

9) Laboratory testings:

Of the 172 human specimens, 86 (50.0%) were identified as *Vibrio parahaemolyticus* positive. The major serum types were K8 (53 cases, 61.6%), K4 (24 cases, 27.9%), K12 (6 cases, 7.0%), and K63 (12 cases, 13.9%). Seven cases had double infections; one had triple.

5. Discussion

When facing a large-scale outbreak of acute diarrheal disease in an institution involving many people, in addition to the foods consumed, water supply system, environmental conditions and human factors shold also be in considered. For incidents such as this, in particular, in which residents of a boarding school with multiple common exposures were involved, particular caution should be used during investigation.

Water supply is a most likely reason for a large-scale outbreak such as this. In this case, tap water was pumped up to the water tower for use by all students and teachers. The water as a probable cause could be eliminated since not every person from the school became ill.

Environmental conditions could also be a possible reason, as more persons who had eaten in the student's dining room became ill than those who had eaten in the teacher's section, as revealed by the questionnaire which showed three times more students than teachers were affected. However, foods were prepared and served from the same kitchen by the same staff, who also handled dishes and utensils. No significant difference was found when the attack rate was tested by dining rooms (Table 3). That the attack rate for students was higher that for non-students (teachers and other employees) was considered not to be the result of their having eaten meals in different dining rooms, but rather because many non-students neither breakfasted nor dined in the school. It was considered reasonable that the attack rate of students should be higher that for non-students, and that environmental factors could also be eliminated.

Laboratory tests pointed to the likelihood of *Vibrio parahaemolyticus* in this instance. Its incubation period is 2 to 48 hours, with clinical symptoms such as abdominal pain and diarrhea accompanied by nausea, vomiting, fever and headache. The major sources of infection are raw fishery products and shellfishes, crabs in particular[2]. In sufficient freezing, inadequate cooking and poor handling of foods can bring about contamination[3]. In view of the incubation period and the clinical symptoms associated with this incident, it seemed obvious that the outbreak was induced by *Vibrio parahaemolyticus*. The question? Where did it come from?

The two most-likely food items sources were salted peanuts and the celery; according to the school, the peanuts were supplied in sealed packages by one dealer, soaked in water over the night of 23 August, cooked at 5 am on the 24th, and served at 6:30 that morning. The celery and bean curd were boiled, then cooled and dressed with sauce. It was not possible to be sure how these foods were supplied and stored. A

"crab with onion" was served for dinner on 23 August. After the crab was defrosted at 3 pm the same afternoon, then fried and cooked with onion. No information was available as to the processes of storage, preparation and supply of these foods, nor were specimens available for laboratory testings, no evidence could be found to indicate that either the peanuts or the celery had been contaminated by the crab, although the possibility could not be eliminated.

From the time of onset, 12 cases had diarrhea before breakfast on 24 August: 5 of them became ill between 7 and 10 pm on 23 August; 7 between 12 and 5 am on 24 August. These 12 cases may have been: 1) by-chance diarrheal cases, since out-patient records showed that 50 cases had visited the clinic because of diarrhea and gastroenteritis in the month of July. Normally, only severe cases would visit a clinic for medical care. Assuming that 1 out of every 4 cases would visit clinic, for those 50 cases there probably were a total of 200 symptomatic cases, making an average of 6 to 7 cases per day "normal". These 12 cases were the ones which could or would happen on any day; 2) a result of recall bias. Information was collected on 30 August and bias could certainly occur when attempting to accurately remember experiences from seven days previously; 3) the dinner of 23 August was also related to the infection. Four serum types of *Vibrio parahaemolyticus* had been isolated in the human specimens, and they could conceivably come from different foods. Most of those who had dinner on 24 August had breakfast the next morning. According to the multiple logistic regression analysis, the risk from dinner could be covered by the breakfast and chances of multiple exposures should not be overlooked.

6. Conclusion and Recommendations

In an institution where many people share a common life or experience, they are exposed to common sources of infection over a period of time. This is quite different from a casual dinner where an encounter is brief and temporary and any source of infection is easier to define. To consider the causes and sources of infection of a group outbreak such as this, when laboratory findings are not yet available, consideration must also be given not only to the foods ingested but also to the water supply source, and the environmental plus human factors. In the present investigation, neither food nor environment specimens were available, and only speculation was possible. It is recommended, therefore, that:

1) at least one sample of each food item should be retained at 5°C for two days when an outbreak occurs.

2) foods should be kept warm or refrigerated after cooking and before serving. To avoid cross-contaminations of food, those which are raw and those cooked should be separated stored in the freezer. Care should be taken to avoid freezer overloading.

3) all kitchen staff should be professionally trained with classes on food sanitation provided regularly. In particular, new staff should receive instruaction in food management and cleanliness.

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