

Epidemiology Bulletin

209 Investigation of a Food Poisoning
Outbreak in a High School in Yunlin
County, Taiwan, 2002
221 Cases of Notifiable Diseases, Taiwan,
R.O.C.

Investigation of a Food Poisoning Outbreak in a High School in Yunlin County, Taiwan, 2002

Abstract

On September 25, 2002, a food poisoning outbreak occurred in a private high school in Yunlin County. For restricted cooperation on the part of the school, only 502 students of the junior high third grade and the senior high third grade were interviewed with a semi-structured questionnaire. Of them, 77 (60 male and 17 female students) met the case definition of food poisoning, accounting for 15.3% of those interviewed. Major clinical symptoms included fever (9.6%), chill (9.4%), weakness (9.2%), nausea (8.8%), vomiting (8.0%), and dizziness (6.6%). Incubation period ranged from 5 to 44 hours, with a median and a mode of 18 hours each. In 18 rectal swabs, *Vibrio parahaemolyticus* was isolated in 14 (77.8%). It was, therefore, decided that the pathogenic agent of the present outbreak was *Vibrio parahaemolyticus*.

According to the results of single and multivariate analyses of the food items of the school lunch, it was found that the squid roll was significantly associated with the food poisoning (the age-adjusted odds ratio, 1.95 and 95%

confidence limit, 1.08-3.50). The other food items, salty eggs, pork cooked with onion, stirred-fried spinach, and bean-curd soup were not found to be statistically associated with the food poisoning (all 95% confidence limits including 1.0). Food materials in the freezer were poorly arranged and squid rolls were not protected from contamination might explain that the squid roll was the cause of the incident.

Introduction

Changes of society have made parents work away from home and their children's lunch is often overlooked. In some schools of remote areas, school lunch is provided. The process of preparing school lunch is rather complicated. Any inattention could easily lead to food poisoning incidents. On the evening of September 25, 2002, students of a private high school in Yunlin County began to develop some gastro-intestinal symptoms of diarrhea, abdominal pain, vomiting, and nausea. One hundred and ninety-eight and 30 students were sent to the Buddhist Tzu-Chi Dalin General Hospital and Yunlin Hospital of Department of Health (DOH) respectively for care. Many cases had their dinner the night before and breakfast of the day at different places. The school had not seen cases of similar symptoms for some time. A food poisoning outbreak likely to be associated with the school lunch of the day was suspected. To understand the scope of the outbreak, the pathogenic agent, and the food items responsible, an investigation team of the Field Epidemiology Training Program (FETP) of Center for Disease Control of DOH and persons from the Yunlin County Health Bureau joined together for an epidemiological investigation.

Materials and Methods

Subjects for investigation

Students of the high school who had the lunch supplied by the kitchen on September 25 and developed symptoms such as diarrhea were investigated. Due to limited assistance from the school authority, only students of the junior high third grade and the senior high third grade were interviewed with a semi-structured questionnaire.

Tools of Investigation

A semi-structured, self-filled in questionnaire was used. For each person interviewed, questions included demographic information, onset of illness, time of onset, symptoms or signs, medical care, and food items taken.

Definition of Case

A food poisoning case was defined as whoever had the lunch supplied by the school kitchen on September 25, and developed diarrhea at least twice per day and any two of the following symptoms of nausea, vomiting, headache, abdominal pain, and fever.

Laboratory Testing

On September 26, the Yunlin County Health Bureau collected rectal swabs from 18 patients, two food specimens, and four environmental specimens. They were sent to the Third Branch Office of the CDC and the Central Region Laboratory of the National Laboratories of Foods and Drugs for laboratory testing. Test items included *Vibrio parahaemolyticus*, *Bacillus cereus*, *Salmonella*, *Staphylococcus aureus*, and *E. coli*.

Survey of Environment

Surveys of the dining room, the kitchen, the freezer, management of the kitchen staff, and process of food preparation, were conducted. The residual chlorine of the tap water was tested.

Data Processing and Analysis

Data collected were keyed-in, verified, and analyzed with Epi-Info 2000

and SAS-PC System[®] Version 8.1 for Windows. Food items were conducted single and multivariate analyses separately. Crude odds ratios (COR) and their 95% confidence limits (CL) were used to study the association of each food item with the incident. Age difference between the junior high and senior high students was adjusted and corresponding age-adjusted odds ratios and 95% confidence limits were calculated. Microsoft Excel software[®] was used to draw the distribution of incubation periods.

Results

A total of 502 students were interviewed with a return rate of 100.0%. Of those interviewed, 77 met the definition of case. They are 60 males (77.9%) and 17 females (22.1%), giving an attack rate of 15.3% (77/502). Attack rates by class are shown in Table 1. The third grade of senior high students had higher attack rate than the third grade of junior high students (18.3% against 10.7%). The distribution of their clinical symptoms mainly were, fever 9.6%, chill 9.4%, weakness 9.2%, nausea 8.8%, vomiting 8.0%, and dizziness 6.6%. Cases appeared one by one starting 5:00 p.m. of September 25, and reached a peak at 6:00 a.m. of September 26. Incubation periods ranged from 5 to 44 hours, with a median and a mode of 18 hours each (Figure 1).

Results of single food item analysis (Table 2) showed that the crude odds ratio of the salty eggs was 2.73 (95% confidence limit at 1.64-4.62); of the pork cooked with onion was 2.52 (95% confidence limit, 1.49-4.27); of the squid rolls was 2.85 (95% confidence limit, 1.69-4.81); of the stirred-fried spinach was 2.31 (95% confidence limit, 1.37-3.91); of the bean curd soup was 3.12 (95% confidence limit, 1.78-5.46); and of the corn cake was 2.00 (95% confidence limit, 1.14-3.51). These food items all had significant statistical association with the food poisoning (their 95% confidence limits

not including 1.0). The steamed rice, with a crude odds ratio of 1.57 (95% confidence limit, 0.90-2.63), was not found to be significantly associated with the incident (95% confidence limit including 1.0).

Results of age-adjusted analysis of food items (Table 2) found that all food items, except the steamed rice, had significant statistical association with the food poisoning (95% confidence limits not including 1.0). The risk of food poisoning for those who had the salty egg was 2.73 times higher than that of those who did not take the salty egg (95% confidence limit, 1.66-4.88). The odds ratio for the pork cooked with onion eaters was 2.49 times higher than the non-eaters (95% confidence limit, 1.51-4.10). The odds ratio of the squid roll eaters was 2.76 times higher than the non-eaters (95% confidence limit, 1.67-4.54). The odds ratio of the stirred-fried spinach eaters was 2.25 times higher than the non-eaters (95% confidence limit, 1.37-3.70). The odds ratio of the bean curd soup eaters was 3.02 times higher than the non-eaters (95% confidence limit, 1.77-5.13). The odds ratio of the corn cake eaters was 1.33 times higher than the non-eaters (95% confidence limit, 0.93-1.93). The odds ratio of the steamed rice eaters was 1.56 times higher than the non-eaters (95% confidence limit, 0.92-2.63).

Results of multivariate analysis of the food items (Table 3) showed that only the squid rolls had significant statistical association with the food poisoning (95% confidence limit not including 1.0). The age-adjusted odds ratio was 1.95 with 95% confidence limit 1.08-3.50. The rest food items no longer had significant association with the incident, and their 95% confidence limits all included 1.0). The age-adjusted odds ratio of the salty egg was 1.60 (95% confidence limit, 0.90-2.86); of the pork cooked with onion was 1.54 (95% confidence limit, 0.88-2.71); of the stirred-fried spinach was 1.67 (95% confidence limit, 0.93-3.01); and of the bean curd soup was 1.09 (95%

confidence limit, 0.55-1.99).

Laboratory testing isolated *Vibrio parahaemolyticus* in 14 out of 18 rectal swabs (77.8%) and *Bacillus cereus* in one of the two lunch box specimens. Environmental surveys revealed that there were 10 kitchen workers. Of them, six had licenses for C grade Chinese cooking technicians, and eight had been to food sanitation training courses. No wounds were found on the hands of any kitchen workers. They all wore hats and gloves when working. The residual chlorine of the tap water tested on 27 September was 0.4 ppm, meeting requirement. The cooking, preparation, and washing tables were relatively clean. There was water in some parts of the kitchen floor. The store spaces outside the kitchen for seasonings, food materials, and dried food were untidy with flies. Wastes and food leftovers were kept at random in corners. By asking the chef the sources of the food of the day, and the way food was kept and arranged in the freezer, it was found that the squid and the miso were bought from the same supplier the day before; and the sliced pork, salty eggs, bean curds, corn cakes, and spinach were delivered to the school on that day by different suppliers. They were then washed, sliced, and cooked in three pots. The squids kept in water and placed in the freezer were not contamination-proof. Food materials for the day were kept under them. Food materials in the freezer were not properly arranged. Hot meals were supplied by the school. Food after cooking was placed in boxes and sent to designated areas. Students from each class delivered these lunch boxes to their classmates.

Discussion and Conclusion

For rather restricted cooperation on the part of the school, no epidemiological investigation for entire student and faculty population was possible. From the investigation of the 502 junior and senior high third

grade students assigned by the school, it was found that the incubation periods of the 77 affected students showed a single peak distribution (Figure 1), ranging from 5 to 44 hours, with a median and a mode of 18 hours each. This fact suggested that the incident was an outbreak. Major symptoms of food poisoning are fever, chill, weakness, nausea, vomiting, and dizziness. In 14 of the 18 rectal swabs, *Vibrio parahaemolyticus* was isolated; 13 of K6 serotype, and 1 of unidentified type. They were specific features of *Vibrio parahaemolyticus* infection. It was therefore decided that the pathogenic agent of the incident was *Vibrio parahaemolyticus*. Though in one of the two box specimens, *Bacillus cereus* was isolated, the symptoms and incubation periods of the cases did not correspond with those of *B. cereus* infection (the incubation period is 6-24 hours)⁽¹⁾. *Bacillus cereus* should have not been the pathogenic agent of the present incident.

Vibrio parahaemolyticus is commonly found on shells and fish in marine waters⁽²⁾. A freshly caught marine product for instance, if the number of colonies on the surface is 10^2 CFU/gm, at the time it reaches the market, the number of colonies could increase to 10^3 - 10^4 CFU/gm, and a poisonous dosage of 10^5 - 10^7 CFU/gm in three to four hours. Contaminated food containers are the major reason of poisoning. Intake of not properly frozen, contaminated, or not fully cooked fishery products, intake of raw fishery products, and cooked food not properly kept can also induce food poisoning of this kind. *V. parahaemolyticus* can also contaminate food indirectly through hands, rags, chopping boards, knives and other utensils to cause food poisoning^(3,4). Single and multivariate analyses of food items by adjusting for ages showed that the squid roll was significantly associated with the outbreak (95% confidence limit not including 1.0). The kitchen was not properly kept. Food materials in the freezer were poorly arranged. The

squid rolls in water were not contamination-proof. These findings all suggested that squid rolls were most likely the food item associated with the present incident.

In the 2,290 cases of food poisoning reported by the Department of Health for the period 1981-2001, 860 were due to *Vibrio parahaemolyticus*, accounting for 67.2% of all bacterial food poisoning incidents⁽⁵⁾ during that period. In the same period, food poisoning outbreaks in schools accounted for 20.0% (440 cases) of all food poisoning incidents. *V. parahaemolyticus* thus is most vital to the prevention of food poisoning⁽⁵⁾. In 2001, there were 178 cases of food poisoning in the Taiwan Area. Of them, the *V. parahaemolyticus*-associated cases were induced primarily by the cross-contamination of raw and cooked food⁽⁵⁾. Cautions should be taken in the preparation of food. By investigation, it was suspected that the present incident was a result of poor storage of food materials and inadequate washing of cooking utensils. The school was advised to store food materials soon after procurement in freezer in three sections, dried food materials, materials for the day, and materials for the next few days. Dried materials should be kept contamination-proof in the lower part of the freezer. The other two materials should be further grouped into the easily-contaminated and general food materials for management. The principle of "first bought, first use" should be practiced to avoid further cases of food poisoning. The kitchen, dining room, and drains should be maintained regularly. Kitchen utensils should be kept clean. Tap water should be tested regularly for residual chlorine. If possible, visits should be made to nearby GMP food factories to learn about ways to maintain food sanitation. Wastes and food leftovers should be properly disposed of. Flies should be controlled, and good food hygiene practices should be practiced.

Soon after the incident, the school began to practice the Hazard Analysis Critical Control Point (HACCP) system^(6,7) to improve their self-control of food sanitation. HACCP is a process to control each step of food manufacturing through hazard analysis to decide the critical control points (CCP) to control CCP, to decide on measures for the monitoring of CCP, and to keep effective records of processing and to establish review procedures. HACCP system may vary from the specific features of products, processing conditions, manufacturing techniques, and quality of manpower. The school should focus on the principles of clean food, quick processing, heating or freezing of food materials, and avoidance of negligence to improve their preparation of school lunch. If necessary, they should ask the health authorities for help to build up an effective and sustainable monitoring system, and to practice the good food hygiene practices to avoid any future food poisoning incidents. Relevant regulations on the control of fishery products should also be enforced to prevent fishery products from inducing food poisoning⁽⁸⁾.

Acknowledgement

The authors wish to thank the Yunlin County Health Bureau, the Central Region Laboratory of the National Laboratories of Foods and Drugs of the Department of Health, and the Division of Research and Laboratory Testing of the Center of Disease Control, the Department of Health, for their assistance in the present investigation.

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Figure 1. Distribution of Incubation Periods for Food Poisoning Cases in Yunlin High School, Yunlin County, 2002

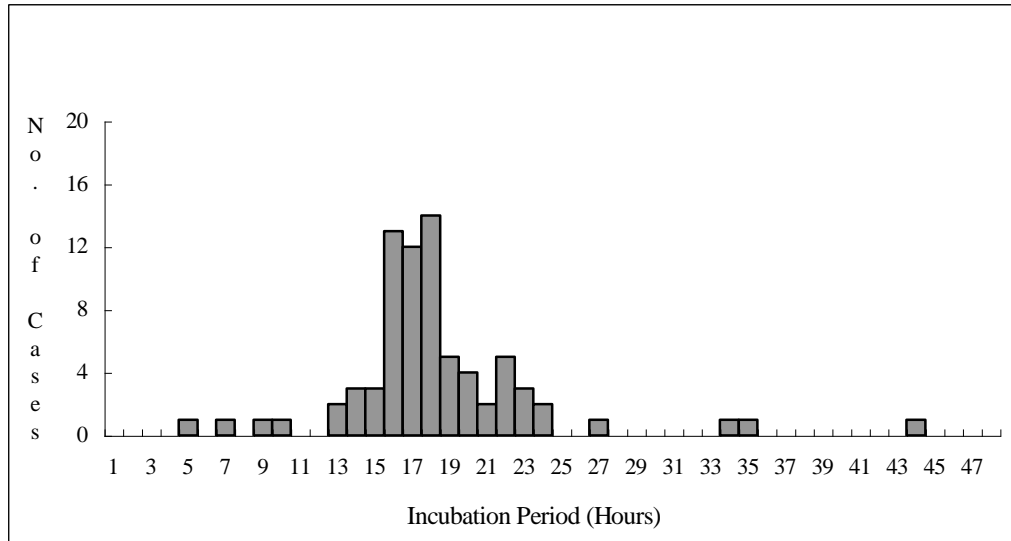


Table 1. Number of Food Poisoning Cases and Corresponding Class-specific Attack Rates in Yunlin High School, Yunlin County, 2002.

Grade	Jr. High 3 rd Grade					Sr. High 3 rd Grade									Total
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	
N	40	39	42	34	41	35	38	25	40	29	27	32	40	40	502
No. of Cases	4	3	2	6	6	8	4	7	8	13	9	1	2	4	77
Attack Rates (%)	10.0	7.7	4.8	17.6	14.6	22.9	10.5	28.0	20.0	44.8	33.3	3.1	5.0	10.0	15.3

Table 2. Results of Single Food Item Analysis for the Food Poisoning Outbreak in Yunlin High School, Yunlin County, 2002

Food Item	Sick			Not Sick			Crude Odds Ratio(95% CL)	Age-Adjusted Odds Ratio(95% CL)
	Eaten	Not Eaten	Exposure Ratio	Eaten	Not Eaten	Exposure Ratio		
Salty egg*	39	38	1.03	116	309	0.37	2.73 (1.64-4.62)	2.73 (1.66-4.48)
Pork with onion*	47	30	1.57	163	262	0.62	2.52 (1.49-4.27)	2.49 (1.51-4.10)
Squid roll*	42	35	0.88	126	299	0.42	2.85 (1.69-4.81)	2.76 (1.67-4.54)
Stirred fried spinach*	36	41	0.60	117	308	0.34	2.31 (1.37-3.91)	2.25 (1.37-3.70)
Bean curd soup*	29	48	0.60	69	356	0.19	3.12 (1.78-5.46)	3.02 (1.77-5.13)
Corn cake*	26	51	0.51	86	338	0.25	2.00 (1.14-3.51)	33 (0.93-1.93)
Steamed rice*	26	51	0.51	104	321	0.32	1.57 (0.90-2.73)	56 (0.92-2.63)

*95% confidence limits of age-adjusted odds ratios do not include 1.0, hence are statistically significant.

Table 3. Results of Multiple Food Items Analysis for the Food Poisoning Outbreak in Yunlin High School, Yunlin County, 2002

Food Item	Age-Adjusted Odds Ratio(95%CL)
Salty egg	1.60 (0.90 ~ 2.86)
Pork with onion	1.54 (0.88 ~ 2.71)
Squid roll*	1.95 (1.08 ~ 3.50)
Stirred fried spinach	1.67 (0.93 ~ 3.01)
Bean curd soup	1.09 (0.55 ~ 1.99)

*95% confidence limit of age-adjusted odds ratio does not include 1.0, hence is statistically significant.