

## **An Epidemiological Investigation of a Food Poisoning Outbreak at an Elementary School in Penghu County**

### **Abstract**

The purpose of this epidemiological investigation was to identify the causes of the food poisoning outbreak, the likely responsible food items and the pathogenic agents. A semi-structured questionnaire with the case-control method was used to interview 176 students of an elementary school in Huhsi Township of Penghu County. Among them, 171 (97.2%) students ate the boxed lunch ordered for the school's track and field sports. Of the 171 students, 109 (48 males and 61 females) met the case definition of food poisoning and showed an attack rate of 63.7%. Their symptoms included abdominal pain (79.8%), vomiting (78.0%), dizziness (71.6%), diarrhea (46.8%), headache (45.0%), weakness (32.1%), nausea (25.7%), fever (23.9%), and chills (8.3%). The median incubation period was 33 hours and the range was from 6 to 54 hours.

By analyzing the association of the three food items (hamburger, fried chicken quarter, and coke) in the boxed lunch, with the food poisoning incident, the coke was found to have the highest odds ratio of 9.08, with a 95% confidence limit of 1.71-64.165. The odds ratio of the fried chicken quarter was 1.51, with a 95% confidence limit of 0.53-4.29. That of the hamburger was 0.50, with a 95% confidence limit of 0.18-1.36. Although the coke was found statistically to be significantly associated with the food poisoning, there were no laboratory findings to confirm the relationship.

Due to the fact that the incubation period was relatively long, the major symptoms appeared, and ampicillin proved to have satisfactory result in treating the hospitalized students, it was suspected that enterotoxigenic strains of *Escherichia coli* (ETEC) was the likely pathogenic agent. The agent could have originated from the ETEC contaminated ice cubes placed in the coke.

### **Introduction**

An elementary school in Huhsi Township of Penghu County had its annual track and field event in the morning of May 16, 1999. At noon, school children ate their boxed lunch containing hamburger, fried chicken quarter, and coke, ordered by the school. Several hours later, tens of students began developing symptoms such as abdominal pain, vomiting, dizziness, diarrhea, and headache. Many of them were sent to the local clinics for medical treatment. Some seriously ill students were taken to the Military Penghu Hospital for emergency care or hospitalization. The Center for Disease Control of the Department of Health (DOH) responded to this situation and dispatched an investigation team from the Field Epidemiology Training Program (FETP) to explore the cause, food items, and the pathogenic agents possibly related to the food poisoning outbreak.

### **Materials and Methods**

#### 1. Study subjects

176 students, out of the 212 (eliminated 10 mentally retarded and 26 kindergarten students), of an elementary school in Huhsi Township of Penghu County were interviewed. Since school teachers and employees did not eat the boxed lunch and none of them developed symptoms, they were excluded from the interview.

#### 2. Case definition

A case of food poisoning was defined as one who had attended the track and field sports on May 16, 1999, ate the boxed lunch ordered by the school, and developed at least three of the following symptoms: abdominal pain, vomiting, dizziness, diarrhea, and headache. Under the same circumstances, one who developed at least two of the above symptoms and requiring medical treatment, or having vomiting only but requiring medical treatment was also counted as a case. However, students with symptoms such as cough and runny nose but not medically treated were excluded.

#### 3. Study method

The case-control method was applied. Students meeting the criteria of a case were assigned to the "case" group and students not meeting the criteria were categorized into the "control" group.

#### 4. Investigation tool

A semi-structured questionnaire was used to interview each of the 176

students. The questionnaire contained items such as the demographic information, time of eating lunch, types of food consumed, symptoms of illness, time of onset of symptoms, medical treatment, and time of recovery.

#### 5. Inspection of the school environment

The FETP team visited the school on May 19 to inspect its environment (such as water supply and treatment, sanitary conditions of the kitchen), procedures of track and field contest, distribution of the lunch boxes and their consumption. Records of student absences regarding one week before and after the food poisoning incident were also collected. The school nurse was asked for the reasons for students' visits to the school clinic during this two weeks period.

#### 6. Visit to hospitalized students

On May 19, students undergoing treatment at the Military Penghu Hospital were visited to ascertain their conditions, medical care, medication, and recovery.

#### 7. Inspection of the food preparation site

A small restaurant in Makung City supplied the boxed lunch. The restaurant was visited on May 19 to determine its sanitary conditions, sources of food materials and their storage, food handling process, and food transportation.

#### 8. Specimen collection

Human specimens: the Military Penghu Hospital collected rectal swabs from students for bacterial testing on May 17. On the following day the Penghu County Health Bureau collected two specimens of vomitus from sick students and two specimens of flora from the hands of the restaurant employees for bacterial testing which were conducted by the 4<sup>th</sup> branch bureau of the Center for Disease Control, DOH. The testing items included *Staphylococcus aureus* and its enterotoxin, *Bacillus cereus*, *Salmonella*, pathogenic *Escherichia coli*, and *Vibrio parahaemolyticus*.

Food and environmental specimens: The Penghu County Health Bureau collected one specimen each from the leftover of the bread, hamburger meat, and fried chicken quarter at the school; one each of the hamburger meat, fried chicken quarter, coke, and salad from the restaurant (all prepared on May 18). More over, one specimen from each of fresh chicken quarter and fresh hamburger meat, the water used for washing and cooking, and the food preparation table was sampled. All collected food and environmental specimens were sent to the Southern Branch Laboratory of the National Laboratories of Foods and Drugs, DOH, for laboratory testing.

#### 9. Data processing

Questionnaire information was keyed-in with the Epi-Info software<sup>2</sup>. Each variable was examined carefully for its input. In addition to the description of each variable, Chi-square test and Fisher's exact test were used for the analyses of the categorical variables. Odds ratios (OR) and their 95% confidence limits

(CL) were also calculated to establish the association between food items and the food poisoning outbreak.

## Results

### 1. Inspection of the school environment

The school had eight classes with a total of 212 students in Classes 1A, 1B, 2A, 3A, 4A, 5A, 6A, kindergarten, and a special class for mentally retarded students. All classes mainly located in a newly constructed three-story building. Tap water is supplied in this building and filtered for drinking purpose.

The track and field contests began at 8 o' clock ill the morning on May 16 and continued until 12:40. Lunch boxes were then distributed to each class. Most students took the lunch boxes home. The school record showed that one student called ill sick 011 May 14, one 011 the 15th, one on the 16th, none 011 the 17th (as it was a declared holiday), fifty-eight 011 18th, thirty-nine on 19th, nine on 20th, one 011 2 1st. None of students took sick leave after May 22. It is noted that the number of absences increased significantly 011 May 18 and 19 right after the school's track and field event.

### 2. Visit to Patients Undergoing Hospitalization

Most of the students treated at the Military Penghu Hospital had vomiting. Some had diarrhea, but lot severe. They were treated with ampicillin, supportive care (such as intravenous drip for fluid and electrolyte replacement), and progressive diets (after the termination of vomiting, sports drinks or rice water, and then mashed apple or rice gruel) with satisfactory results. Most of the children recovered in one to three days. Although the number affected was large, only eight were briefly hospitalized (for one to three days).

### 3. Inspectioll of the food processing site

A total of 260 lunch boxes were ordered. They were prepared at 7:30 a.m. and delivered to the school at 11:40 a.m.. The boxed lunches were supplied by a small family-owned restaurant ill Makung City. The restaurant opens all day and provides three meals: sandwiches, hamburger and milk for breakfast; and fast- food (rice with fried chicken quarter, for instance) for lunch and dinner. The restaurant can serve forty customers at its maximum capacity and occasionally does take-out orders. The food materials used for the boxed lunch 011 the day of the school's track and field sports, lamely bread, hamburger meat, and raw chicken quarters, were in frozen form, packaged in cartons, produced and delivered directly from the Taiwan. They were then placed in a freezer for storage at - 18°C. The frozen food materials were placed in the refrigerator for defrosting before use. The tap water not only was used for washing, but also was filtered and stored in buckets for drinking and making ice cubes.

The defrosted hamburger meat was fried, then placed on the toasted bread, salad and dressings were added to the box. The defrosted chicken quarters were first coated with baking powder, then fried in a quantity of 20-30 each time. The fried chicken quarters were then moved to a nearby kitchen table for

placing in boxes. Carbonic acid water was mixed with the condensed coke to make the soft drink. The coke was then placed in cups and ice cubes were added.

#### 4. Laboratory testing

Of human specimens: The Military Penghu Hospital identified *Escherichia coli* from the rectal swabs of hospitalized students. No further typing was made. From the specimens of vomitus, the 4<sup>th</sup> Branch Bureau of the Center for Disease Control, DOH, identified *Bacillus cereus* in one case.

Of food and environmental specimens: The Southern Branch Laboratory of the National Laboratories for Foods and Drugs, DOH, was unable to identify *Salmonella*, *Staphylococcus aureus* and its enterotoxins, *Bacillus cereus*, and pathogenic *Escherichia coli* from any of the food and environmental specimens.

#### 5. Analysis of questionnaire

The 176 returned questionnaires, 83 males (47.2%) and 93 females (52.8%), indicated that 171 students (97.2%) ate the boxed lunch. Of them, 109 met the criteria of a case and brought about an attack rate of 63.7% (109/171). Five students did not eat the boxed lunch and developed no symptoms of food poisoning. It was therefore concluded that the incident was associated with the boxed lunch ordered by the school ( $p < 0.01$ ).

Of the 109 cases, 48 (44.0%) were males and 61(56.0%), females. Their distribution by class is shown in Table 1. Their symptoms consisted of abdominal pain (79.8%, 87/109), vomiting (78%, 85/109), dizziness (71.6%, 78/109), diarrhea (46.8%, 5 1/109), headache (45.0%, 49/109), weakness (32.1%, 35/109), nausea (25.7%, 28/109), fever (23.9%, 26/109), chills (8.3, 9/109), and other symptoms (3.7%, 4/109). Of the 98 cases who remembered the onset time of symptoms, the median incubation period was calculated to be 33 hours, the mode was 42 hours, and the range, 6-54 hours (Figure 1).

The association between the three food items, namely the hamburger, fried chicken quarter, and coke, and the food poisoning incident is shown in Table 2. Of the 109 cases, 87 ate the hamburger, 98 ate the fried chicken quarter, and 107 drank the coke. However, 22 cases that did not eat the hamburger became ill; 11 cases that did not eat the fried chicken quarter became ill; and 2 who did not drink the coke also became ill. It therefore seemed that coke was the most likely item associated with the food poisoning; the next likely was the fried chicken quarter; the hamburger was the least likely item concerned. The results of univariate analysis (Table 3) indicated that the coke was significantly related to the food poisoning outbreak (OR, 9.08; 95% CL, 1.72 - 64.16). Both the fried chicken quarter (OR, 1.51; 95% CL, 0.53 - 4.29) and hamburger (OR, 0.50; 95% CL, 0.18- 1.36) were not statistically significant.

## Discussion and Conclusion

The number of students taking sick leave increased suddenly on May 18 and 19 soon after the school's track and field event, and returned to normalcy after May 21. The incubation periods ranged from 6 to 54 hours with a mode of 42 hours. Their distribution followed a single-peak curve (Figure 1). It was then speculated that the food poisoning incident of the elementary school was an outbreak of one common source of infection. In addition, from the fact that the students admitted at the Military Penghu Hospital showed a significant increase in the number of white blood cells, and that they responded quite well to ampicillin treatment, the likelihood of viral infection was excluded.

The Military Penghu Hospital identified *Escherichia coli* from the rectal swabs of students under hospital care. As no further sub-typing was made, it was not possible to determine whether the *Escherichia coli* in question was a common agent or the pathogenic agent. The 4th Branch Bureau of the Center for Disease Control, DOH, isolated *Bacillus cereus* in one vomitus specimen. However, the incubation period in that case was 43 hours long, and thus did not correspond to that of a *Bacillus cereus* infection (1-6 hours for the vomiting type, and 8-16 hours for the diarrhea type)<sup>5</sup>. Therefore, it is unlikely that *Bacillus cereus* should have been the pathogenic agent. From the long incubation period of this incident (average of 33 hours, ranging from 6 to 54 hours), the major symptoms of abdominal pain (79.8%), vomiting (78.0%), dizziness (71.6%), diarrhea (46.8%), and headache (45.0%); and the food items contained in the lunch box, hamburger, fried chicken quarter, and coke, it was suspected that *Salmonella* and enterotoxigenic strains of *Escherichia coli* (ETEC) were the likely pathogenic agents.

The incubation period of *Salmonella* infection has a long range of 6 to 72 hours, averaging 12-36 hours. Its symptoms are sudden onset of headache, abdominal pain, diarrhea (for several days), nausea, and sometimes vomiting. Dehydration can be serious. Fever and loss of appetite are common<sup>(5,6)</sup>. *Salmonella* is frequently found in half-boiled eggs or egg products, fresh milk or milk products, meat or meat products, and poultry or poultry products. The number of cases with fever in this incident was not high (23.9%), and the time required for recovery was short (1-3 days). Although the odds ratio of fried chicken quarter was 1.51, it was not statistically significant ( $p > 0.05$ ). The probability of *Salmonella* being the pathogenic agent was eliminated.

The incubation period of the enterotoxigenic strains of *Escherichia coli* can be as short as 10 to 12 hours, averaging 24-72 hours. The major symptoms are watery diarrhea with little mucus and no blood, abdominal cramps, vomiting, acidosis, prostration, and dehydration, with mild or no fever. These symptoms usually last no longer than 3-5 days<sup>(5,7,8)</sup>. The pathogenic agent is often found in contaminated food and water. The incubation period, the symptoms, the time needed for recovery, and foods consumed of the present incident all met the

special features of an infection by enterotoxigenic strains of *Escherichia coli*. Thus, the enterotoxigenic strains of *Escherichia coli* were considered to be the pathogenic agent of the food poisoning.

The outbreak of food poisoning occurred after the school's track and field event. Many of those who ate the boxed lunch became ill. However, those without eating the boxed lunch did not get sick. A junior high school in the same county had a school's track and field sports the day before May 15. Their students ate a boxed lunch of fried chicken quarter and coke supplied by the same restaurant, and a food poisoning outbreak occurred subsequently. The distribution of symptoms and mode of onset (such as the incubation period) were similar to those of the elementary school. These food poisoning outbreaks should therefore be considered to be associated with the boxed lunch provided on the days of school's track and field sports.

Chi-square test of the food items eaten gave a high odds ratio of 9.08 for the coke, which was statistically significant ( $p < 0.01$ ). The odds ratio for the chicken quarter was 1.51 and for the hamburger was 0.50. Both were not statistically significant ( $p > 0.05$ , respectively). The coke seemed to be highly associated with the outbreak of food poisoning. The ice cubes contained in the coke were prepared by the restaurant. If the water used for making the ice cubes was contaminated by enterotoxigenic strains of *Escherichia coli*, it could have been the source of infection of the present incident.

Of the 251 students of the junior high school who consumed the fried chicken quarters, 39.0% (98/251) complained that the chicken quarters were not well cooked and the chicken meat was still bloody. It was evident that the restaurant, unable to handle larger orders at one time, failed to fry the chicken quarters thoroughly, and they could have been contaminated. In their demonstration, cooks manually handled both raw and fried chicken quarters at the same time, so they could have been cross-contaminated.

Hamburgers, fried chicken, and coke, due to their fast preparation, service, easy carry out, and convenience, have become very popular. Schools frequently order them. However, if schools are not alert enough to ask suppliers to save some samples, in case of food poisoning, no food specimens can be collected for laboratory testing. At the elementary school for instance, only one piece of hamburger bread without meat, one piece of hamburger meat without bread, and one leftover of chicken quarter were collected. No unconsumed coke was available. There was, therefore, no laboratory evidence to support the statistical analysis of the likely pathogenic food items.

## **Recommendations**

1. Local medical institutions, when treating many patients of similar symptoms coming from the same source, should immediately notify local

- health authorities for the purpose of controlling disease (including food poisoning) spread and initiating an epidemiological early disease investigation if needed.
2. For the purpose of identifying the incriminating food items and pathogenic agents responsible for food poisoning outbreak, health authorities should make efforts to collect more specimens from affected persons, food remnants and the study environment as early as possible.
  3. Fast food suppliers must strictly observe regulations concerning the hygienic and sanitary conditions of food materials, food products, the working environment, and the process of food handling. In particular, at the time of large orders, more caution should be taken.
  4. Schools should always save a few complete samples of the foods ordered for laboratory testing by health authorities at the time of food poisoning outbreaks.
  5. On regular inspections, in addition to examining the sanitary conditions of foods and environment, the standard procedures of food handling should also be made an important aspect of inspection.
  6. Health authorities should improve health education for food handlers.

### **Acknowledgement**

The authors wish to thank the Penghu County Health Bureau, the Huhsi elementary school of Penghu County, the Military Penghu Hospital, the 4th Bureau of the Center for Disease Control, DOH, and the Southern Branch Laboratory of the National Laboratories of Foods and Drugs, DOH, for their assistance in the investigation.

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Table 1. No. of Food Poisoning Cases and Attack Rate by Class

Class	No. Eaten Food	No. of Cases	Attack Rate (%)
1 A	20	12	60.0
1 B	20	13	65.0
2 A	28	18	64.3
3 A	24	13	54.2
4 A	25	15	60.0
5 A	34	25	73.5
6 A	20	13	65.0
Total	171	109	63.7

Figure 1. Distribution of Incubation Periods Related to Food Poisoning Outbreak (N=98)

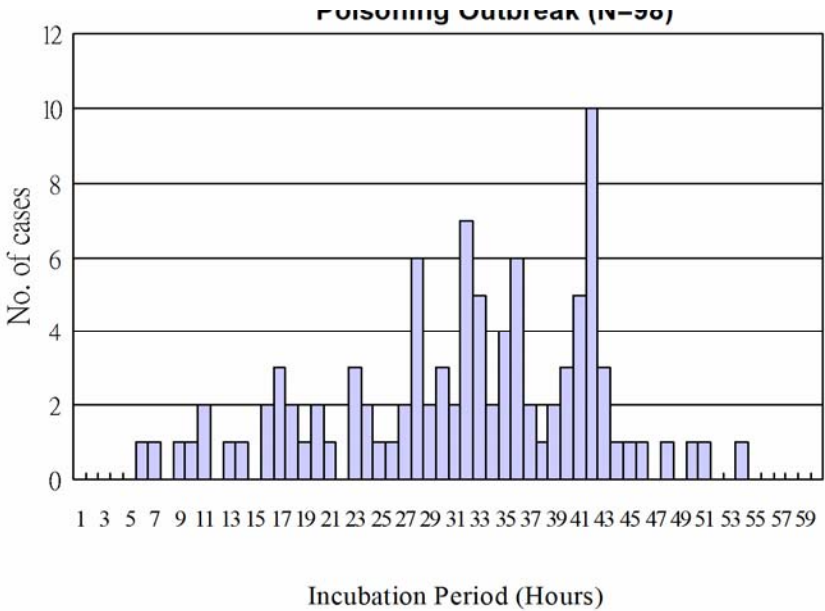


Table 2. No. of Food Poisoning Cases by Food Items Consumed

Food Items			No. of Cases
Hamburger	Fried Chicken Quarter	Coke	76
Hamburger	Fried Chicken Quarter		2
Hamburger		Coke	9
	Fried Chicken Quarter	Coke	20
		Coke	2
Total			109

Table 3. Odds Ratio and 95% Confidence Limit Related to Each Food Item in the Food Poisoning Outbreak

Food	No. of Ill			No. Not Ill			Odds Ratio (95% CL) (7)=(3)/(6)
	Eaten (1)	Not Eaten (2)	ER (3)=(1)/(2)	Eaten (4)	Not Eaten (5)	ER (6)=(4)/(5)	
Hamburger	87	22	3.95	55	7	7.86	0.50 (0.18~1.36)
Fried Chicken Quarter	98	11	8.91	53	9	5.89	1.51 (0.53~4.29)
Coke	107	2	53.50	53	9	5.89	9.08 (1.72~64.16)*

ER: exposure ratio; CL: confidence limit.

\*p<0.01, statistically significant.