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An Epidemiological Investigation of a Food Poisoning Outbreak among Philippine Workers in an Electronic Factory in Chungli, Taoyuan County, Taiwan

1. Introduction

Purchasing a large number of boxed lunch has become popular for schools, organizations, factories and companies to consume. However, statistics on food poisoning reported by the Department of Health [(1)] showed that of the 39 food poisoning outbreaks known of their causes in 1995, 13 (33.3%) were attributed to boxed lunches.

At 5 pm on 5 September 1996, some Philippine workers of an electronic factory in Chungli City, after having taken boxed lunches supplied by Factory A of Hsinchuang City, Taipei County, began at 10 pm of the same day, to develop symptoms of food poisoning such as diarrhea, abdominal pain, and vomiting. Some of them had been sent to the Lihsing and the Huayang Hospitals for treatment. At the request of the Taoyuan County Health Bureau, the Bureau of Food Sanitation and the FETP of the Department of Health joined together for an epidemiological investigation to understand the cause of the incident and to identify the food items responsible and the pathogenic agents.

2. Materials and Method

Subjects for Investigation:

A questionnaire survey was conducted to all Philippine workers of factories I and II. Of the 210 interviewed, 135 (64.3%) were male, and 75 (35.7%) female. Their ages ranged from 20 to 36 years, with the majority in the 22 to 29 age groups.

Method of Investigation:

Each respondent was interviewed face-to-face with a questionnaire. The questionnaire

contents included personal background information, length of stay in Taiwan, whether had the Philippine style boxed lunch on that evening, time of eating, items of food taken, any uncomfortable feelings, onset of symptoms, types of symptoms, frequency of diarrhea, medical care, and time of recovery.

Data Processing and Analysis:

Each copy of the questionnaire was first keyed-in with Epi-Info. Each variable was then checked for its accuracy. The curve of incubation period was processed with Excel 5.0 of Microsoft Windows 3.1. Statistical analysis was conducted with SAS 6.11. χ^2 method was mainly used to test the relationship between the incident and the food supplied; the time of eating; and the items of food taken.

Laboratory Testings:

Human specimens: 45 rectal swab specimens were collected from suspected cases on 6 September by the Taoyuan County Health Bureau and examined by the National Institute of Preventive Medicine. Laboratory testings were conducted for: *Vibrio parahaemolyticus, Staphylococcus aureus, Salmonella, Salmonella typhi, Salmonella paralyphi, Bacillus dysenteriae,* and *Aeromonas spp.*

Food and environmental specimens: leftovers of food were discarded on 5 September. Factory A could not be contacted with. Hence, neither food nor environmental specimens were collected.

3. Results

Of the 210 workers interviewed, 183 had the Philippine style boxed lunches supplied by Factory A. Of them, 32.2% (59/183) had developed food poisoning symptoms such as diarrhea, abdominal pain, and vomiting. The rest 27 had the local style boxed lunches supplied by Factory B and none had developed any symptoms. χ^2 test showed that the food supplied by Factory A was related to the incident ($p < 0.05$).

Of the 183 who had food supplied by Factory A, 167 had complaints of diarrhea (64.7%, 108/167), abdominal pain (25.1%, 42/167), dizziness (6.0%, 10/167), vomiting (4.2%, 7/167), nausea and chill (1.2% each, 2/167), fever (0.6%, 1/167) and others (9.6%, 16/167) (see Table I for their distributions). A case, therefore, was defined as one who had the Philippine style boxed lunch supplied by Factory A in the afternoon of 5 September 1996 and had two or more times of diarrhea and at least one of the following symptoms: abdominal pain, dizziness, vomiting, nausea, chill, and fever. 59 of the 183 met the criteria, giving an attack rate of 32.2% (59/183).

The length of stay in Taiwan of these 59 Philippine workers ranged from one month to one year and ten months: 15% (9/59) of them had been in Taiwan for six months

Table 1. Frequency of Self-reported Symptoms of 167 Workers

Nausea	Vomiting	Abdominal Pain	Diarrhea	Fever	Chill	Dizziness	Others#	No.	%
–	–	–	+	–	–	–	+	12*	7.2
–	–	–	+	–	–	+	–	7	4.2
–	–	–	+	–	–	+	+	1	0.6
–	–	–	+	–	+	–	–	1	0.6
–	–	–	+	+	–	–	–	1	0.6
–	–	+	+	–	–	–	–	30**	18.0
–	–	+	+	–	–	–	+	1	0.6
–	–	+	+	–	–	+	+	1	0.6
–	–	+	+	–	+	–	–	1	0.6
–	+	–	+	–	–	–	–	5	3.0
–	+	+	+	–	–	–	–	1	0.6
+	–	–	+	–	–	–	–	1	0.6
+	+	–	+	–	–	–	–	1	0.6
–	–	+	–	–	–	+	–	1*	0.6
–	–	+	–	–	–	–	–	7	4.2
–	–	–	–	–	–	–	+	1	0.6
–	–	–	+	–	–	–	–	95	56.8

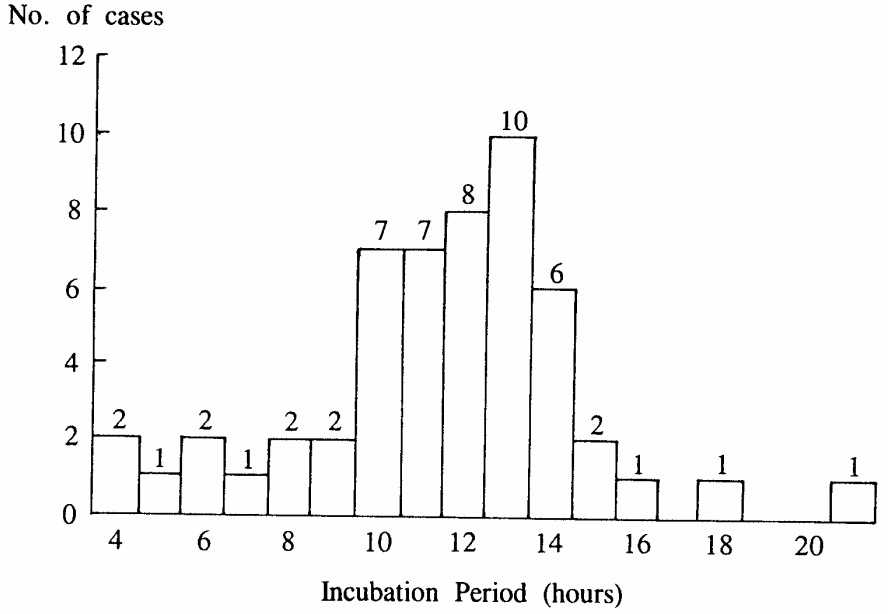
haded area indicates cases met by the criteria.
* One person had only one time of diarrhea, did not meet criteria.
** Three persons had only one time of diarrhea each, did not meet criteria.
# weakness, stomach ache, etc.

and less, 7% (4/59) between six months and one year, and 78% (46/59) for more than a year. While comparing to the length of stay for the 124 non-infected Philippine workers, this food poisoning incident was not found to be related to the length of stay ($p > 0.05$).

Of those 59 who became ill after taking the food supplied by Factory A, 54 had the food at 5 pm, five at 6 pm, and one at 7 pm. By comparing with the time of food intake of the non-infected Philippine workers, the results of Logistic regression and Wilcoxon tests showed, the incident was not found to be associated with by the Philippine workers having left-overs of the boxed lunches ($p > 0.05$).

These 59 cases became ill 4 to 21 hours (the incubation period) after the intake of food, with a median of 12 hours and a mode of 13 hours. The incubation periods (Figure 1) followed a normal distribution, with a mean of 12 hours and a standard deviation of 3 hours.

Figure 1. Distribution of Incubation Period for Philippine Workers with Food Poisoning in an Electronic Factory



Note: Incubation period was not available for 6 cases.

The relationship between each food item and the incident was tested with χ^2 test. On the day, each box of food contained menudo, mixed vegetables, pickled mango, and rice. Menudo (Philippine, also known as mechado in Spanish) is pork and pork liver fried in the Philippine sauce. The mixed vegetables could be, according to the reports of the Philippines workers, cooked with a mixture of green beans, cauliflower, and carrots. The pickled mango was mango sliced and pickled. Table 2 lists results of analysis by each food item. Menudo seemed to be related to the poisoning ($p < 0.05$) and could be the pathogenic agent. Though 3 1.0% of those who had other foods (mixed vegetables, pickled mango, and rice) had become ill, their relationship were not statistically significant (each p value larger than 0.05), these food items were therefore not considered responsible. As there was only one food item considered responsible, no cross analysis of all food items was made.

Of the 45 rectal swab specimens sent to the National Institute of Preventive Medicine for lab**oratory test**ings, *Aeromonas* spp. was found in 13 specimens.

Table 2. Results of Univariate Statistical Analysis for Each Food Item

Food	Eaten			Not Eaten			OR (3) / (6)
	Ill (1)	Not Ill (2)	Attack Rate (%) (3)=(1)/[(1)+(2)]	Ill (4)	Not Ill (5)	Attack Rate (%) (6)=(4)/[(4)+(5)]	
Menudo	38	47	44.7	21	75	21.9	2.04*
Mixed vegetables	20	42	32.3	39	80	32.8	0.98**
Pickled mango	15	30	33.3	44	92	32.4	1.03**
Rice	27	49	35.5	32	73	30.5	1.16**

OR indicates Odds Ratio.
* χ^2 test, $p<0.05$.
** χ^2 test, $p>0.05$.

4. Discussion

Morgon and Wood [2], in their review of several epidemiological studies, stated that as compared to stools of normal persons, a higher rate of *Aeromonas* spp. was identified in the stools of diarrheal patients, and hence *Aeromonas* should be held responsible for gastroenteritis of the diarrheal type. Figura et al. [3] reported statistical relationship between *Aeromonas* and gastro-enteritis of the diarrheal type. Some studies [4], however, showed no relationship between *Aeromonas* and diarrhea. The issues of whether *Aeromonas* is the sole pathogenic agent of gastroenteritis of the diarrheal type or whether it works jointly with other pathogens to cause gastroenteritis of the diarrheal type are still under debate[5].

Aeromonas is a gram-negative bacillus. Two types of *Aeromonas, Aeromonas hydrophila* and *Aeromonas sobria*, are associated with gastroenteritis [5]. The former, more commonly seen, causes watery diarrhea and mild fever. The latter induces diarrhea, and blood and mucus in stools. Gracey et al. [6] pointed out that one-quarter of *Aeromonas*-induced gastroenteritis are caused by the latter.

Aeromonas can survive in fresh water and is pathogenic to both human and animals. On 16 April 1984, the Beijing City Disease Control Station and the Tungcheng District Disease Control Station isolated *Aeromonas* from both the left-overs and the utensils and containers used by 48 food poisoning victims who shared some cooked pork, and also from stools of two patients and preliminarily verified the toxigenicity of *Aeromonas*[7].

The optimal temperature for the survival of *Aeromonas* is 29℃ to a high of 42℃.

More is found in the summer and autumn. *Aeromonas* can be isolated from animal food, aerobic plants, sea food (such as fish, shrimps, shellfish, oyster), poultry, dairy products, air-packed beef and pork, and bottled mineral water5. From the questionnaire interviewing, menudo was found to be associated epidemiologically and statistically with the food poisoning. The odds ratio of 2.04 for menudo was higher than that of other food items. It was quite likely that the pork, pork liver or the Philippine sauce (ingredients unknown) were contaminated by *Aeromonas*. For those who did not eat the three items, 31% still became ill (Table 2). Thus, the other three food items could have also been contaminated by memudo. However, these three food items should not be counted as the causes of the incident. The lunch boxes were delivered by Factory A at 4 pm. They should have already been prepared by one or two o'clock of that afternoon. The unsanitary conditions of food or the cleanness of the raw materials could be the cause.

The incubation period of *Aeromonas* ranged from 7 to 20 hours, though 80% of victims developed symptoms within 8 to 18 hours. Clinical symptoms began with the uncomfortable feeling of the upper abdomen, and very soon, 95% of the patients developed abdominal pain and watery diarrhea, one to three times a day, and even four to seven times a day. Only a few patients had nausea and vomiting, and very few patients had fever. The illness continued for one to three days [(7)]. Findings of the present investigation (such as an incubation period of 4 to 21 hours; mainly diarrhea as the clinical symptom; recovery within one day) corresponded with these characteristics. Also, *Aeromonas* was isolated from 13 of the 41 human specimens. It is concluded that *Aeromonas* was associated with the incident was without doubt.

Literature [(5)] also indicates that *Aeromonas* is sometimes a collaborative agent of food poisoning. Gastroenteritis induced by *Staphylococcus aureus* is short in its incubation period, often between two to four hours [(8)]; this outbreak could not be due to *Staphylococcus aureus*. However, the pathogenic agent of this incident could also be *Bacillus cereus* [(8)]. As the food factory was unable to be investigated, there were no ways to collect food specimens, and to learn about the sources of the raw materials, the process of food preparation, the process by which the boxed lunches were supplied, the environment of the factory, and the health conditions of the food handlers. Therefore, there was no evidence available to indicate that Bacillus cereus could be the agent. Whether *Aeromonas* was the sole pathogenic agent of this incident requires further investigation. In general, local health authorities, in dealing with food poisoning outbreaks of this kind, should immediately inspect the food factory concerned and collect relevant specimens and other information to help in identifying the possible items of food responsible for the incidents, their pathogenic agents and the route of infection.

5. Recommendations

1. While ordering boxed lunches in large quantity, schools, organizations, factories and companies should know in advance the environment of the factories, the conditions of the utensils, the source of raw materials and their process of procurement, storage

and the temperature and time under which the food is prepared, and the personal hygiene of the food handlers to see if they meet the requirements. Suppliers under contract should be told to save one sample in refrigerator at each time of delivery for laboratory testings in the case of any future food poisoning outbreak. Factories should be asked to provide information on the sources of food materials and the process by which they are procured. These requests should make the suppliers be more concerned with the sanitary conditions of their products.

2. Lunch boxes should be ordered from properly registered factories. The food factory in this case left without any trace after the incident, the electronic factory had no means to ask for any compensation.

3. For the prevention of food poisoning, food should be kept and processed “clean”, “prompt”, “heated”, and “frozen”. In the preparation of boxed lunches, by regulations, the process of food procurement, utensils used, places of preparation and storage, and the handlers should be kept clean and sanitary. Food should be consumed soon as well. Food should not be kept for more than two hours in summer, and more than three hours in winter between preparation and consumption. To prevent the growth of microbes, food should be kept under temperatures unsuitable for the survival of microbes, that is in the refrigerator under 4℃ or under 18℃ in the freezer. Food should be heated and boiled before eating.

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References:

1. Department of Health: Food Poisonings in the Taiwan Area, 1995.
2. Morgan DR, Wood LV. Is *Aeromonas* species a foodbome pathogen? Review of the clinical data. J Fd Safety 1988; 9:59-68.
3. Figure N, Marvis L, Vendioni S. Prevalence, species differentiation and toxigenicity of *Aeromonas* strains in cases of childhood gastroenteritis and in controls. J Clin Microb 1986; 3:595-599.
4. Millership SE, Curnow SR, Chattopadhyay B. Fecal carriage rate of *Aeromonas hydrophil*a. J Clin Microb 1983; 36:920-923.
5. Stelma GN Jr. *Aerornonas hydrophila*. In: Doyle MP. Foodborne Bacterial Pathogens. New York: Marcel Dekker Inc. 1989; 2-19.

6. Gracey M, Burke V, Robinson J. *Aeromonas*-Associated Gastroenteritis. Lancet ii: 1982; 1304-1306.
7. Sheng IP. Prevention of Some Common Food Poisonings. Holiday Publisher, Taipei, May 1992.
8. Benenson AS. Control of Communicable Diseases Manual, 16th ed, American Public Health Association 1995; 183-194.