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A Shigellosis Outbreak at a Primary School in Kuanhsi, Hsinchu County

Intmduction

On 15 October 1997, a student of a primary school in Kuanhsi Township of Hsinchu County was treated at the Taoyuan Minsheng Hospital for abdominal pain and diarrhea. Laboratory testings later found that he was infected with Shigellosis. On 21 October, the Hospital notified the local health authorities on one hand and sent the strain isolated from the rectal swab of the student to the National Institute of Preventive Medicine, DOH, for confirmation. On 23 October, the strain was nfirmed as Group D Shigella. Staff of the Kuanhsi Township Health Station then visited the school for investigation on 24 October. It was found that since 4 October, several students had taken leave for fever, diarrhea, abdominal pain, vomiting and headache. The number of sick students reached a peak on 16 and 17 October (21 and 20 students respectively). On 24 and 27 October, the Hsinchu County Health Bureau together with the local health station collected 153 rectal swabs of students and 7 environmental specimens for laboratory testings by the Bacteriology Division of the NIPM. A team of the FETPINIPM, the National Quarantine Service, the Bureau of Communicable Disease Control of the DOH, the Hsinchu County Health Bureau and the Kuanhsi Township Health Station visited the school on 29 October for investigation and to exert measures of control.

Materials and Methods

1. The Environment

   The school is located in the eastern part of Kuanhsi Township of Hsinchu County. There are 13 classes in the school: three classes of the first grade with 86 students, two of the second with 81 students, two of the third with 70 students, two of the fourth with 78 students, two of the fifth with 57 students, and two of the sixth with 70 students, totaling 442 students: 241 males and 201 females. There are 25 teachers and other staff members.

Water in use comes from both the underground and the tap water. The underground water is collected from two shallow wells Nos. 1 and 2. Well No. 1 is located in the school garden and Well No. 2 behind the classrooms. Water is pumped up from Well No. 1 to a water tower and then through pipes to washing basins, toilets and the school garden for hand-washing, toilet-flushing and flower-watering. Water through pipes from Well No. 2 is collected in a tank near the toilet behind Class rooms 3A and 3B. The water is also pumped up to a water tower for hand-washing and toilet-flushing. Tap water is used for drinking and cooking of school lunch. This water is also piped to washing basins and there it is mixed with the underground water. Underground water is used when tap water is in short supply.

Drinking water is supplied in both warm and cold boiled water. The warm drinking water is boiled tap water piped to three washing basins and supplied through three taps marked “warm drinking water”. The three taps are located one on the second floor near the Principal’s Office; one near the Health Center, and one near the Teachers’ Office on the first floor. The cold drinking water is boiled tap water pumped up to a stainless water tank and then piped to three washing basins and supplied through three taps marked “cold drinking water”. In addition to the taps supplying drinking waters, there are in the three basins taps for hand-washing. Underground and tap water is used together for the purpose.

School lunch is supplied Monday through Saturday at 12 noon to 1 pm. Cooking facilities are sound with dish-washer and high-pressure sterilizer for washing and sterilization of utensils.

2. Questionnaire Interviewing

On 30 October, a structured questionnaire was administered to all teachers and students. The questionnaire included questions on the time of onset, symptoms, using water for drinking, washing of hands and face, tooth-brushing and mouth rinsing at school, having school lunch, illness of family members and their conditions.

3. Collection of Specimens

The Kuanhsi Health Station had collected 467 rectal swabs of teachers, staff members and students and 7 environmental specimens for laboratory testings on 24 through 30 October. As Shigellosis infection was suspected, a simplified standard Shigella testing operational procedure[(1)] was adopted. That is, rectal swabs were placed directly on SS (Salmonella-Shigella) culture agars under 37℃ for 18-24 hours. 1,000 mL of water specimens was collected. The specimens were grouped into three: two of 400 mL each were added meat broth culture agar of double concentration for bacterial multiplication or filtration with filters. The filters were then placed on SS agars under 37 ℃ for 18-24 hours. Suspected colonies were then selected and placed on TSI (Tri-Sugar-lion) agar, Christensen Citrate, Urea agar, SIM (Sulfite-Indole-Motility), VP (Voges-Proskauer), Lysing decarboxylase under 37℃ for 18-24 hours for

the confirmation of Shigella. They were then serologically typed with anti-sera of Seiken, Japan.

4. Definition of Case

A “confirmed case” was defined as one who, during the period between 1 October and 10 November 1997, had diarrhea at least twice a day and one of the following symptoms: fever (38℃ and above), abdominal pain, vomiting, nausea, tenesmus; and the laboratory findings being Shigella positive.

A “suspected case” was one who had, during the same period, diarrhea at least twice a day and one of the following symptoms: fever (38 ¢XC and above), abdominal pain, vomiting, nausea, tenesmus; the laboratory findings, however, being negative.

A “carrier” was one with positive laboratory findings though without the above-mentioned symptoms.

A “normal person” was one with negative laboratory findings and without the above-mentioned symptoms.

“Cases” for statistical analysis in the present investigation included “confirmed cases”, “suspected cases1” and “carriers”.

5. Data Processing and Analysis

Data were keyed-in with Epi-info and confirmed of the accuracy of each variable. SAS was then used for description and analysis. x -test was primarily used for statistical analysis. Relative odd ratios and their 95% confidence intervals were used to indicate risks of infection by factors.

Results

467 copies of the questionnaire had been returned with a response rate of 100%. Of them, 243 (239 students and 4 staff members) met the criteria of a ¡§case¡¨, giving an attack rate of 51.2% (243/467). Table 1 gives the attack rates by class: 12.8% for the first grade (11/86), 38.3% for the second grade (31/81), 34.3% for the third grade (24/70), 29.5% for the fourth grade (23/78), 35.1% for the fifth grade (20/57) and 20.0% for the sixth grade (14/70). The second and the fifth grades had higher attack rates. Of the 239 students, 202 gave dates of onset. The epidemic curve showed that most of them became ill on 16 and 22 October, with a median of 22 October.

467 rectal swabs were collected from 442 students and 25 teachers and staff members. Of them, 123 specimens from the students (positive rate at 27.8%, 123/442) and 4 from the staff members (positive rate at 16.0%, 4/25) were found positive. Of the 528 rectal swabs collected from family members, 11 were found positive, giving a positive rate of 2.1 % (11/528). Of the 7 environmental specimens, one underground water specimen collected from the tap of a washing basin was found positive, giving a positive rate of 14.3% (1/7). Of the 123 cases with cultures positive of Shigella, 76 had developed symptoms (the “confirmed cases”), and 47 without symptoms (the “carriers”). Symptoms of the confirmed and

suspected cases were similar (Table 2), mainly watery diarrhea, fever and abdominal pain.

Analysis of relevant factors suggested that underground water was a likely risk factor. Boiled water either warm drinking water, cold drinking water, or water brought from home was protective; their relative odds being 0.69 (95% confidence interval at 0.56-0.85), 0.73 (95% confidence interval at 0.59-0.91) and 0.68 (95% confidence interval at 0.55-0.86) respectively, all statistically significant (p lower than 0.05). When compared with those who rarely brushed teeth/rinsed mouth after meal with water from the washing basin, the relative odds were 1.40 (95% confidence interval at 1.05-1.85) for those who did so regularly (4-6 times a week); and 1.15 (95% confidence interval at 0.84-1.57) for those who did so occasionally (2-3 times a week). This fact seemed to indicate a dosage effect between the use of washing basin water for tooth-brushing/mouth rising and infection (statistically significant, p lower than 0.05). That is, those who brushed teeth/rinsed mouth more often with water from the water basin were more likely to be infected. It could therefore be induced that using underground water for tooth-brushing/mouth rising was a risk factor of infection. Washing face with water from washing basin was not statistically associated with infection ($p>0.05$). Washing hand after toilet with water from washing basin was not statistically associated with infection either ($p>0.05$). All teachers and students had the school lunch. The school lunch should not be associated with the infection.

Testings for antibiotic sensitivity of the Group D Shigella strains isolated (Table 4) showed that antibiotics such as Ceftriaxone, Nalidixic acid, Chioramphenicol, Cefotaxime and Defuroxime were inhibitory to the strains; that the strains were resistant to Cephalothin and Amoxicillin; and that the strains were either sensitive or resistant to Amikacin, Kanamycin and Cefixime pending upon the dosage of the antibiotics used.

Discussion

Thus far, Shigella species was still the major pathogenic agent of diarrhea2. In the first half of the 20th century, Shigella dysenteriae, also known as Group A Shigella, was the major cause of Shigellosis. Shigella, however, has been practically wiped out in most developed countries, and is replaced by Group B Shigella, Shigellaflexneri, and more recently by Group D Shigella, Shigella sonnei3. Studies by Pan show that large-scale outbreaks of dysentery in Taiwan are primarily caused by Group D Shigella, whereas the sporadic cases of dysentery are the result of Group B Shigella infection4. Bacillary dysentery is a notifiable communicable disease of Shigella infection. The infection is transmitted through direct contact and also by contaminated drinking water or food5. Major symptoms are: fever (38 ¢XC and above), diarrhea (at least twice a day), nausea, vomiting, abdominal pain, cramps, weakness and tenesmus.

From the epidemiologic investigation and laboratory testings, it was noted that the present infection was transmitted primarily by contaminated underground water. Those who had the underground water for either drinking or tooth-brushing/mouth rinsing had higher relative odds. Group D Shigella was also isolated from the underground water collected from taps. As some family members had also been infected or isolated Shigella, another likely route of infection was direct contact. Reports[10-12] have indicated that outbreaks of bacillary dysentery by water are common; that direct contact is also a major route of infection; and that food can also be a medium of infection [13-14]

In the present outbreak, some suspected cases already occurred in early October. They were thought to be common diarrhea. For lack of microbiological testing facilities, primary care units were unable to identify the infection and report timely. It was only on 16 October when a student was treated for abdominal pain and diarrhea at the Taoyuan Minsheng Hospital that the case was reported as Shigellosis. Immediate action was then taken by health authorities for laboratory testings, medication of cases and positive cases, prophylactic medication of susceptible individuals, disinfection of the environment, and interruption of the sources of infection by shutting down the underground water.

The infection was quickly brought under control by the joint efforts of the health authorities and the school. After the last case was identified on 6 November 1997, no further cases were reported. As the disease could also be transmitted through direct contact, and an intake of a mere 10-100 bacteria could induce infection, some family members of students were also infected. These members included children of nearby schools, kindergartens and nurseries and some adults: four school children of Primary School A, two of Kindergarten A, six of Kindergarten B, one of Kindergarten C, 9 of Nursery D, one of Primary School B, and 17 family members (totaling 40). These students and family members were found to be epidemiologically related, and could have been infected through direct contact.

Recommendations

1. Training of primary care units should be strengthened to make them more alert to notifiable diseases.
2. More sentinel physicians should be added. They should be told to immediately collect specimens of suspected cases for laboratory testings for the early detection of cases. Do not postpone testings until patients are treated at medical care institutions with microbiological testing facilities.
3. A disease reporting system should be established in schools. If the number of students on sick leave of similar symptoms increases, the local health authorities should be informed immediately.
4. Schools should be required to use tap water. Government should subsidize the costs. Toilets and septic tanks should be checked regularly for leaks.

5. Health education of the public should be strengthened. People should be told to keep the environment clean, prevent cockroaches and flies from contaminating food and water, avoid drinking directly from tap, avoid eating raw food, drink only boiled water, and wash hands with soap and tap water before meal and after toilet.

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Table 1. Distribution of Confirmed Cases

Class	No. of Students	No. of Confirmed Cases	Attack Rate (%)	Date of Onset of Index Case
1A	29	6	20.7	10/25/97
1B	27	2	7.4	10/16/97
1C	30	3	10.0	10/12/97
2A	45	20	44.4	10/06/97
2B	36	11	30.6	10/02/97
3A	36	12	33.3	10/22/97
3B	34	12	35.3	10/04/97
4A	39	9	23.1	10/12/97
4B	39	14	35.9	10/03/97
5A	29	8	27.6	10/07/97
5B	28	12	42.9	10/13/97
6A	35	9	25.7	10/12/97
6B	35	5	14.3	10/24/97
Total	442	123	27.8	10/02/97

Figure 1. Dates of Onset (N=202)

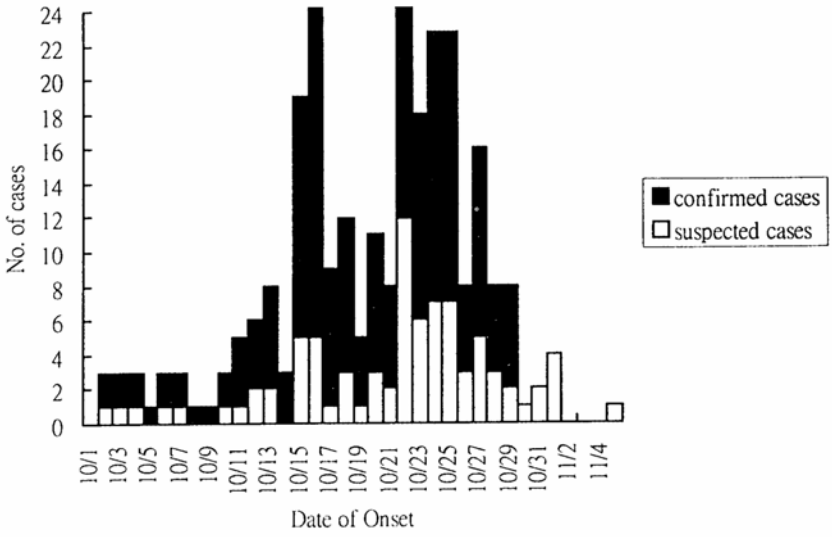

Table 2. Symptoms of Confirmed and Suspected Cases

Symptoms	Confirmed Cases (76)		Suspected Cases (116)	
	No*	%	No*	%
Diarrhea	76	100.0	116	100.0
Fever	47	61.8	71	61.2
Abdominal pain	44	57.9	59	50.9
Vomiting	32	42.1	44	37.9
Weakness	28	36.8	34	29.3
Nausea	14	18.4	20	17.2
Abdominal cramps	12	15.8	14	12.1
Tenesmus	11	14.5	29	25.0
Conditions of stools				
Watery	54	71.1	58	50.0
Mucous	6	7.9	8	6.9
Bloody	6	7.9	10	8.6
Uncertain	10	13.1	40	34.5

*One case may have more than one symptom.

Table 3. Factors Relevant to the Outbreak

Factors	Cases	Non-cases	Relative Odd Ratio	95% Confidence Interval
Drinking water:				
Drinking boiled warm water	66	64	0.69	0.56-0.85
Drinking boiled cold water	59	50	0.73	0.59-0.91
Brought from home	55	54	0.68	0.55-0.86
Drinking underground water from basin	59	21	1.00	
Tooth-brushing/mouth rinsing after meal:				
Often	121	72	1.40	1.40-1.85
Occasionally	62	58	1.15	0.84-1.57
Rarely or never	31	38	1.00	
Washing face with water from basin:				
Yes	84	67	1.01	0.84-1.20
No	154	125		
Washing hands after toilet:				
Yes	218	191	0.81	0.61-1.06
No	21	11		

"Often" is 5-6 times a week; "occasionally" : is 2-3 times a week; "rarely or never" is less than once a week.

Table 4. Drug Sensitivity of Group D Shigella

Antibiotics	Dosage (μg)	Findings
Ceftriaxone	30	sensitive
Nalidixic acid	30	sensitive
Chlormphnicol	30	sensitive
Cefotaxime	30	sensitive
Cefuroxime	30	sensitive
Amikacin	30	between sensitive and resistant
Kanamycin	30	between sensitive and resistant
Cephalothim	30	resistant
Amoxycillin	25	resistant
Cefixme	5	between sensitive and resistant