Investigation of Shigellosis Outbreak in A Daycare Center in Sijhih City, Taipei County

Donald Dah-Shyong Jiang [1], Wan-Ching Chen [2], Shih-Hao Liu [2]

1. Field Epidemiology Training Program, Centers for Disease Control, Taiwan
2. First Division, Centers for Disease Control Corresponding, Taiwan

From Chinese version, pp,018-029

Abstract

Shigellosis is a highly contagious disease that can easily lead to outbreaks in our community. A doctor from a local hospital reported a case of shigellosis and the case was later tracked to an outbreak of the infection within his family. Afterwards, the infection was then traced through one of the children in that family to his daycare center. Another outbreak of shigellosis was then found at that daycare center. This report investigates the process of infection in the cases, transmission route, possible origin, and the assessment of the effectiveness of the preventive measures taken.

Four members of the Lin family, 29 persons from the daycare center, and 12 other family members of the infected children were involved in this outbreak of shigellosis. 3 members of the Lin family are confirmed cases,

• Received : August 19, 2008. • Accepted : Sep 3,2008.
• Correspodence : Donald Dah-Shyong Jiang
• Address: No.9, Sec.1, Zhongxiao E. Road., Taipei, Taiwan, R.O.C.
• e-mail : djiang@cdc.gov.tw

whereas 5 cases at the daycare center were confirmed cases. Among the 5 confirmed cases at the daycare center, 2 were in the senior class and 3 in the junior class all of which were tested positive for S. sonnei in the rectal samples collected. One of the infected students from the senior class transmitted the disease to his father and younger sister. Due to the fact that 3 of the students started to show symptoms on the 5th and 6th of April, it is suspected that the transmission path is possibly common source infection. Some of the infected persons became carriers not showing any symptoms which may have possibly infected 2 more students with S. sonnei afterwards.

After medial treatment, sanitation of the classrooms and surrounding environment, the quarantine of the middle class students, enhancing of personal hygiene habits, and improving diarrhea report surveillance, the shigellosis outbreak was controlled and then pronounced ended by May 2.

Keywords: shigellosis, *Shigella sonnei*, cluster, epidemiology

Introduction

Shigellosis is highly contagious and is easily found in clusters among our community [1-5]. Both in the country and in other countries, shigellosis outbreaks commonly occur in families [6], communities [1], military troops [3], schools [2], daycare centers [7], preschools [8], reformatory centers [9], mental institutions [4], and mountainous regions [5]. Most of the outbreaks of shigellosis in Taiwan are caused by the Shigella sonnei [10-12]. The differences are only in the time of report and transmission route. The transmission route of S. sonnei can be classified as either contact transmission or common source infection

(through food, drinking water, or shared utensils) [13].

On April 9, 2004, Mr. Lin (Case 1), a 39-year-old man from Sijhih City, Taipei County started to show fever symptoms and sought medical assistance from a local clinic that morning. Midnight of April 10, he started to show symptoms of diarrhea and sought medical assistance at an emergency room at a local hospital in Sijhih City. The hospital tested the case for S. sonnei on April 15 and reported the case to the Public Health Bureau of Taipei County as a suspected shigellosis case. The Public Health Bureau not only sent the strain to the Center for Research and Diagnostics of the Centers for Disease Control (CDC) for further confirmation but also collected 3 rectal swab samples from the cases family members at their home on the 16th. These samples were also sent to the Center for Research and Diagnostics of CDC for tests. The CDC Center for Research and Diagnostics not only confirmed Mr. Lin's case as a confirmed shigellosis case on the 18th but also found the 6-year-old boy (Case 2) and the 4-year-old girl (Case 3) who both attend a daycare center to be infected with shigellosis (the mother showed no symptoms and was tested negative for the S. sonnei). Up until now, the Public Health Bureau along with personnel from both the First Division and the Field Epidemiology Training Program of CDC had conducted an investigation at the daycare center. The purpose of this investigation is to understand if others were infected with shigellosis. If there are others, then the scale of the outbreak, transmission route, and infection source need to be investigated along with the assessment of the effectiveness of the preventive measures.

Materials and Methods

Investigated subjects

The entire body of students in the daycare center and all 29 staff members are investigated.

Questionnaire investigation

With self-designed semi-structural questionnaires, the investigated subjects were interviewed for demography data, infection symptoms, daily meal habits, home drinking water, diarrhea, fever, or vomiting symptoms among family members. The questionnaires were given to the parents of the students to fill out and return.

Case definition

As of April 1, 2008 until May 2, those students, faculty members, or family members that showed at least two of the following symptoms: diarrhea, vomiting, and fever are defined as suspected cases. If a suspected case were to be tested positive for S. sonnei, it is therefore defined as a confirmed case of shigellosis [14].

Sample collecting and laboratory testing

After confirming on April 18 that the 6-year-old son of Mr. Lin was contracted with shigellosis, the Health Station of Sijhih City collected rectal samples from all of the daycare students, staff, and family members. All the samples were sent to the CDC Center for Research and Diagnostics to be tested for the S. sonnei.

Data processing and analysis

All the collected data was entered into the computer using the Epi-info software and then confirmed and collected into the database.

The variables of the questionnaire were calculated and analyzed. The exposure variables and the connection to the infected students are shown with the Relative Risk (RR). Whether the connection showed statistical significance depended on if the 95% Confidence Limits (CL) included 1.00 or not. If the 95% CL included 1.00, this shows that the connection is not statistically significant; thus showing that the exposure variable is not statistically significant to the infection of shigellosis among the students. If the 95% CL is unable to be estimated, then the Chi-square test is used to determine the statistical relevance between the exposure variable and the infection of shigellosis in the daycare center students. If p value is smaller that 0.05, this shows that the exposure variable is statistically relevant to the infection of shigellosis among the students.

Results

A total of 24 questionnaires were collected from the students with 5 from the senior class, 7 from the middle class, and 12 from the junior class. 5 fit the case description with 2 from the senior class and 3 from the junior class. These five cases were also tested positive for S. sonnei by the CDC Center for Research and Diagnostics. Therefore, it is confirmed that the attack rate in this outbreak of shigellosis in A daycare center is 20.8% (5/24). The case symptom distribution is 80.0% each for fever and diarrhea, 40.0% each for vomiting and headaches, and 20.0% each for nausea and stomach aches. An epidemic curve was drawn with the dates of infection (Figure 1) and it shows multiple peaks; thus showing that the transmission route in this shigellosis outbreak was from person to person.

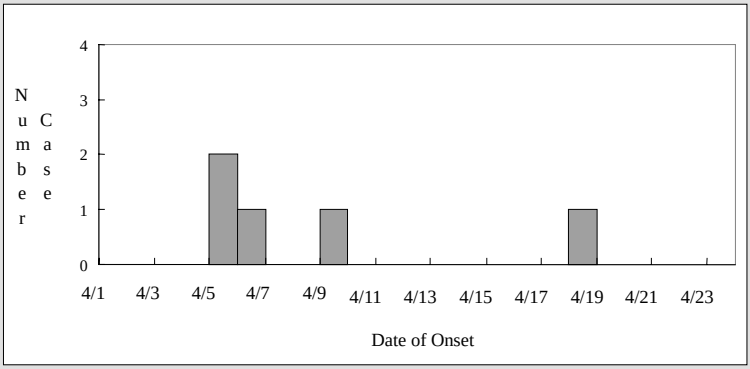

Figure 1. Distribution of Date of Onset of Students with Shigellosis in A DayCare Center

The results of the investigation show that the earliest infected case appeared on April 5 with fever symptoms. Starting the next day until the 13, the student stayed at home due to diarrhea. During this time, the case had sought medical assistance twice at a local clinic in Sijhih City. Shigellosis was not diagnosed those two times. Only until the case showed no more symptoms did he return to the daycare on the 13th. Mr. Lin and his daughter started to show symptoms of fever a diarrhea on the 9th of April and all sought medical assistance at a local hospital in Sijhih City in the morning of April 10 where the daughter was hospitalized. A report was made on the 15th due to the positive results for S. sonnei from samples collected from the father. On the 16th of April, when personnel were conducting an investigation and collecting samples from Mr. Lin's families, they discovered not only that he and his children were showing suspected symptoms of shigellosis, his two children were also enrolled in the senior class and junior class of A daycare center. On April 18, the

CDC Center for Research and Diagnostics confirmed that apart from his wife, Mr. Lin and his two children were infected by S. sonnei. Due to the fact that the preliminary investigation was unsure on the origin of the outbreak in A daycare center, samples were collected from the entire student body and faculty members on the 18th. On the 23rd, results discovered 3 new S. sonnei cases. Among these, one is a male student in the junior class (case 4) which started to show symptoms of fever and diarrhea on the 5th and showed no further symptoms on the 6th of April after seeking medical assistance. Another case is a female classmate of Mr. Lin's son (case 5) who started to show symptoms of fever, vomiting, and diarrhea on April 6 and showed no further symptoms on the 9th after seeking medical assistance. The last case is a female student in the junior class (case 6) who started to show symptoms of fever and diarrhea on the 18th of April.

Table 1 shows the results of the analysis of the questionnaires. The table shows that in common source infection related variables, self-cooked meals (RR=1.07，95%CL= 0.22~5.28), consuming iced products (RR=2.75，95%CL= 0.53~14.25), traveling abroad (RR=0.00，P >0.05), and traveling within the country (RR=0.95，95%CL= 0.13~6.73) all do not show any statistical relevance to the shigellosis outbreak. In personal hygiene, washing after using the restroom (RR=3.38，95%CL= 0.44~26.00), washing hands with soap (RR=1.33，95%CL= 0.18~9.73), biting/licking fingers (RR=0.61，95%CL= 0.08~4.52), and picking nose (RR=6.67，95%CL= 0.88~50.74) also show no statistical relevance to the infection of shigellosis among the students.

Table 1. Results of Exposure Variables Analysis of Shigellosis Infected Students in A Daycare Center

Exposure Variables	Infected	Not infected	Relative Risk (95% CL)
Self-prepared food			
Yes	3	11	1.07 (0.22~5.28)
No	2	8	
Consume iced products			
Yes	1	1	2.75 (0.53~14.25)
No	4	18	
Travel abroad *			
Yes	0	2	0.00 (~)
No	5	17	
Travel within the country			0.95 (0.13~6.73)
Yes	1	4	
No	4	15	
Wash after toilet			
Yes	2	10	0.67 (0.13~3.30)
No	3	9	
Wash before eating			
Yes	4	9	3.38 (0.44~26.00)
No	1	10	
Wash hands with soap			
Yes	4	14	1.33 (0.18~9.73)
No	1	5	
Bite / lick fingers			
Yes	1	6	0.61 (0.08~4.52)
No	4	13	
Pick nose			
Yes	4	5	6.67 (0.88~50.74)
No	1	14	

*None statistical significance, P<0.05.

A total of 25 samples were collected from the students, 4 from the staff members, 15 from the cases' family members, and 3 from the related culinary staff in this outbreak of shigellosis; thus totaling up to 47 samples. Apart from Mr. Lin who was tested positive for S. sonnei in the earliest report, 5 other cases from the daycare center were tested positive for the S. sonnei. The rectal swab samples positive test rate for S. sonnei is 12.8% (6/47). After the cases were confirmed, they were treated with ciprofloxacin (case 1; April 4~19), amoxicillin-clavulanic acid and amoxicillin (cases 2 and 3; April 8~23, twice a day), or ciprofloxacin (case 4~6; April 23~27). Two more samples were taken between April 29 and May 2 as follow-up. Quarantine was terminated when the results came back negative for S. sonnei.

Medical assistance was provided, the classroom environment sanitized with bleach (including desks, chairs, floors, teaching materials, play ground, restrooms, and toilets), middle class students quarantined in another classroom on another floor, the daily questioning and observation of the students, enhancing the washing of hands after using the restroom, and other measures were applied. After two follow-up sample collections and negative results for S. sonnei, the outbreak was deemed over on May 2. In addition, the parents of the infected children were told to notice if any other family members started to show suspected shigellosis symptoms and to enhance personal hygiene habits; therefore, no family members were contracted with the disease.

Discussion

The collecting of fecal samples for culturing is regarded as a

necessity for testing for gastric diseases [15]. However, some studies believe that the results from rectal swab samples are also as effective as fecal samples [16, 17]. The possible reason to the difference in results may be due to the skill in collecting the samples, the person collecting the samples, the method of preservation, the time of preservation, types sent for culturing, testing methods, and testing techniques. However, in collecting samples, it is still important to collect quickly, efficiently, and preserved correctly. It is usually easier for hospitals to collect samples from patients, whether rectal or fecal. In outbreaks among the community, the collection of rectal swab samples must be easier, faster, and more convenient. Sometimes when collecting samples on the weekends, on offshore island, or need to accumulate to a certain number before sending to the laboratory (such as the CDC Center for Research and Diagnostics), the sample is delayed before testing. Due to the fact that rectal swabs contain agar, the sample is easier to remain damp for shipping [18]. This helps in the culturing and testing of the bacteria. Fecal samples do not contain agar; therefore the samples dry out easily and hinders the culturing and testing of the bacteria.

In epidemiology purposes, the main purpose in collecting samples is to find the pathogen of infection in order to treat the subjects and not to confirm a suspected case nor to find possible cases among those showing no symptoms. In the beginning, Mr. Lin was reported to be a suspected shigellosis cases due to the test results. Afterwards, 2 of his 3 family members were also found to be confirmed cases of shigellosis. It is to be noted that the fecal samples taken and tested at the hospital Mr. Lin and his daughter went to with symptoms of fever and diarrhea showed to be

negative for S. sonnei. Thus, we can see that testing alone cannot define a confirmed case.

After interviewing the teachers and supervisor of the daycare center, we know that from the end of March to the beginning of April no children in the daycare showed any signs of fever, vomiting, or diarrhea. The results found in the investigation the Public Health Bureau and CDC conducted at the beginning of April shows 4 cases of symptoms. The health management in the daycare center need enhancement. If the health status of the students can be monitored daily and reported immediately after displaying symptoms, then the infection (if there is one) could be contained and handled more easily and quickly. Two of the students were found infected on April 5 (cases 2 and 4). However, case 2 did not show any symptoms on the 13th but was later tested positive for S. sonnei on the 18th. Case 4 did not show any symptoms on April 6, but was also tested positive for S. sonnei on the 23rd. Another student that was found infected on the 6th of April (case 5) showed not symptoms on the 9th yet was also tested positive for S. sonnei on the 23rd. This proves that the disease is self-limited and with not treatment, the infected person may cease to show symptoms and become a carrier for the disease [13].

The junior class and senior class students are all located on the same floor and share the same learning and activity areas. On the 5th and 6th of April, 3 of the students on this floor contracted shigellosis at the same time. According to the incubation period of the disease (usually 1~3 days and with the maximum of 7 days [13]), even if the children had many chances of being in contact with one another, the chances of infecting on another is quite low. In addition, the daycare center had a three day

holiday starting on April 4 (a Friday), the Tomb-Sweeping Day and the students started to show symptoms after starting the holiday. They did not have common activities or travel together before; therefore, it is not possible that they contracted the disease outside of the daycare center. However, the infections are most likely to come from a common source (such as the daycare center). These infections can be traced back to between March 31 (Monday) and April 3 (Thursday). During this period, the supervisor does not remember nor record the health status of the students. Therefore, it is difficult to trace the contaminated source of the outbreak. In addition, the water used in the daycare center was tested to be 0.05 ppm for residual chlorine, the food and snacks were different each day, and the small scale of the outbreak leads to speculation that the drinking water and food were irrelevant to the shigellosis outbreak. The analysis results of the questionnaire also show no common source of infection. We are only sure that Mr. Lin and his daughter were infected by the disease through his son. Another female student in the junior class (case 6) may have contracted the disease by being in contact with one or more of the 3 infected students that started to show symptoms on the 5th and 6th of April (cases 2,4, and 5). This is due to the fact that the 3 students showed no symptoms before April 18 but was later tested positive for S. sonnei on the 18th or 23rd. This shows that these 3 students were carriers for the disease. Concluding, we can say that the 3 students that started to show symptoms on the 5th and 6th of April may have become infected by the same origin and then later transferred the disease onto the other 3 students.

Although shigellosis has been around for many years, its basic traits

are often overlooked. Although the scale of this shigellosis outbreak was quite small, it provided investigation reference in addition to reassessing the traits of the disease. For example, the symptoms of the infected person diminishes even without medical treatment, but the infected person will become a carrier potent for infecting others in the following 2~3 weeks. In order to cure the infected persons and stop further infections, two samples are collected from the cases for follow-up and tested for S. sonnei. This testing for negative results is an important procedure in preventive measures. In addition, the antibiotics used must be used carefully. According to Ko et al., S. sonnei usually is resistant to ampicillin, chloramphenicol, co-trimoxazole, and tetracycline and therefore not to recommend for treating shigellosis patients [19]. The World Health Organization (WHO) also discourages the use of nitrofurans (nitrofurantoin, furazolidone), aminoglycosides (gentamicin and kanamycin), second and third generations' cephalosporins (cefazolin, cephalothin, cefaclor, cefoxitin), amoxicillin, and other antibiotics that have sensitivity and those that penetrate the mucus membrane for shigellosis patients [18]. WHO also recommends using ciprofloxacin for shigellosis treatment. Usage would be 15mg/kg for children and 500mg/kg for adults. The medicine is to be taken orally twice a day for three days. If the patient is resistant to ciprofloxacin, pivmecillinam, ceftriaxone, and azithromycin can be used instead [18]. Therefore it is recommended that hospitals[A1] not to use amoxicillin-clavulanic acid and amoxicillin in treating shigellosis patients.

Conclusively, when Mr. Lin was diagnosis with shigellosis in a local hospital and reported as a confirmed case, and with the appearance of

suspected shigellosis symptoms in his children, it is speculated that his children are probable shigellosis case due to the fact that they fits the epidemiology link of person (family members), time (within the latent period), and place (living together) factors. In addition, shigellosis is commonly found among young children and the elderly [10-12]. When the health facilities were notified that the children of Mr. Lin were enrolled in a daycare center, samples were collected from the entire student body and faculty staff members on the 18th. At that time, questionnaires should also be conducted in order to find possible cases and infection source. Starting the trace of infection source after the results came out on the 23 had delayed the process of investigation and therefore loose any clues to finding the infection source.

Acknowledgement

This investigation would like to thank the Public Health Bureau of Taipei County, the staff members of the Health Station of Sijhih City and First Division of CDC, physician of preventive medicine, Dr. Yung-Chao Lei, and the staff members of Center for Research and Diagnostics of CDC in assisting with the investigation, collecting samples, and testing. In addition this investigation would also like to thank Miss Yi-Jing Lu of the Field Epidemiology Training Program, CDC for assisting in the questionnaire data input.

References

1. Jiang DS , Yu LW, Huang SC, et al. Epidemiological Investigation of a bacillary dysentery outbreak among residents of an aboriginal village. Taiwan Epidemiol Bull 2007; 23: 72-85.
2. Lu JY, Jiang DS, Wang TK, et al. Molecular epidemiological study of a shigellosis outbreak in Kuanhsi Township, Hsinchu County. Taiwan Epidemiol Bull 1999; 15: 375-84.
3. Jiang DD, Chiou HY, Lee YC, et al. Investigation of Shigellosis Outbreak in a Training Unit in Taiwan County. Taiwan Epidemiol Bull 2006; 22: 471-6. (in Chinese)
4. Jiang DD. Investigation of the infection source of a bacillary dysentery cluster among patients in a psychiatric institution in Hualien County. Taiwan Epidemiol Bull 2006; 22: 653-8.
5. Jiang DD, Jen PL, Huang WC, et al. Investigating Bacillary Dysentery Outbreaks in Dabang and Shanmei Villages of Alishan Township, Chiayi County. Epidemiol Bull 2002; 18: 337-53.
6. Garrett V, Bornschlegel K, Lange D, et al. A recurring outbreak of Shigella sonnei among traditionally observant Jewish children in New York City: the risks of daycare and household transmission. Epidemiol Infect 2006; 134: 1231-6.
7. Shimosako J, Onaka T, Yamanouchi M, et al. An outbreak of extended-spectrum beta-lactamase (ESBL)-producing Shigella sonnei at a day care nursery in Sakai City, 2006. Jpn J Infect Dis 2007; 60: 408-9.
8. Aguirre CT, Cazenave B, Mena RJ, et al. Epidemic outbreak of bacillary dysentery by "Shigella sonnei" in a kindergarten. An Esp Pediatr 1980; 13: 1069-74.
9. Mahoney FJ, Farley TA, Burbank DF, et al. Evaluation of an intervention program for the control of an outbreak of shigellosis among institutionalized persons. J Infect Dis 1993; 168: 1177-80.
10. Jiang TY. Trend analysis of shigellosis in Eastern Taiwan, 1994-2003. Taiwan Epidemiol Bull 2006; 22: 306-19. (in Chinese)
11. Chiu CS, Chen UM, Yang LC, et al. Shigellosis infections in Nantou County: 1995-1999. Epidemiol Bull 2001; 17: 341-58.

12. Pan TM. Trend and prevention of shigellosis. Taiwan Epidemiol Bull 1994; 12: 212-8. (in Chinese)
13. Heymann DL. Control of Communicable Diseases Manual. 18th Ed., Washington DC: Amercian Public Health Association, 2004: 487-91.
14. Taiwan CD. Reporting Guideline of Communicable Disease. 2007; 16. (in Chinese)
15. Kotton CN, Lankowski AJ, Hohmann EL. Comparison of rectal swabs with fecal cultures for detection of Salmonella typhimurium in adult volunteers. Diagn Microbiol Infect Dis 2006; 56: 123-6.
16. Rishmawi N, Ghneim R, Kattan R, et al. Survival of fastidious and nonfastidious aerobic bacteria in three bacterial transport swab systems. J Clin Microbiol 2007; 45: 1278-83.
17. Kaplan RL, Goodman LJ, Barrett JE, et al. Comparison of rectal swabs and stool cultures in detecting Campylobacter fetus subsp. jejuni. J Cli Microbio 1982; 15: 959-60.
18. WHO. Guidelines for the control of shigellosis, including epidemics due to S. sonnei type 1. 2005; 11-3, 33-5, 39-40, 59-61.
19. Ko CF, Yeh HC, Lee YS, et al. Knowing Shigellosis. Taiwan Epidemiol Bull 2006; 22: 659-72. (in Chinese)