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Investigating Bacillary Dysentery Outbreaks in Dabang and Shanmei Villages of Alishan Township, Chiayi County

Abstract

The Saint Martin Hospital of Chiayi County reported on 9 April 2001 a bacillary dysentery case of a 66-year old female in Tefuyeh Tribe of Dabang Village, Alishan Township. As there had never been such cases in this area in the last ten some years, a large-scale epidemiological investigation was conducted. The investigation took primarily the forms of case interviews, survey of the residents, review of medical records of all medical care institutions in Alishan Township, and review of student school attendance, and healthcare records at schools. Surveillance stations for diarrhea patients were set up at the same time at the Alishan Health Station, medical units of the Saint Martin Hospital, the Chiayi Christian Hospital, the Wang FF Clinic, the Wang CL Clinic, the Dabang Primary School, the Sanmei Primary School, and the Dabang and Sanmei nurseries. Any individuals with two or more diarrhea in a day should be reported immediately and their rectal specimens collected for laboratory

testing. These measures were taken to detect suspected cases. The epidemiological survey described the date of onset of each case, their distribution and their personal and geographic relationship to disclose the possible causes of infection and route of transmission.

Between the first confirmed case in Dabang on 9 April till 7 June, 82 cases had been identified (10 confirmed cases, one asymtomatic positive case, and 34 suspects in Dabang, and 14 confirmed cases and 23 suspects in Shanmei). The first case in Dabang became ill on 31 March. The first case in Shanmei became ill on 22 April and her grandmother is a sister of the first case of Dabang. She had visited the case in Dabang. As all cases were related through personal contacts, time of onset and geographically, it was decided that the present bacillary dysentery outbreaks were brought about by person-to-person contacts. It was, however, not possible to decide when and where the outbreaks broke out. By the medical records of the residents, bacillary dysentery did occur in the past, but was in most cases treated as gastrointestinal infections.

The outbreaks concluded on 24 May when the last case was detected. A special feature of this investigation was that all cases were, with the exception of the first case which was reported by the hospital, identified by the health and medical care institutions at all levels through surveillance, symptom reporting, and immediate investigation. Control measures taken at the same time effectively prevented the spread of the infection to other parts of Alishan Township.

Introduction

Bacillary dysentery comes in four types, A, B, C, and D. Type A,

Shigella dysenteriae, is the only one type that produces exogenous toxins and the most severe clinical symptoms. Type D, *Shigella sonnei*, is milder clinically. Type B, *Shigella flexneri*, and type C, *Shigella boydii*, are somewhat between the two in their clinical expressions. These four types though are different in their clinical expressions, they infect basically the gastrointestinal tracts and rarely enter blood vessels. Their major clinical symptoms are sudden watery diarrhea, mucous stools, blood stools, lower abdominal pain, fever, vomiting, and tenesmus[(1)]. Severity and fatality are associated with serotypes. Persons of weak immunity, the elderly, young children, and children in nurseries, kindergartens and care centers are the high-risk groups[(2)]. In industrialized countries, type D is the major cause of shigellosis; whereas type B is more common in developing countries. Outbreaks in Taiwan in the past years are always of types B and D[(2,3)]. In Taiwan, more cases occur in the eastern and the northern parts of the Island. Infections are more prevalent in June through October. In 1995 and 1996, outbreaks occurred however in November and December[(4)]. In 1997 through 2000, more cases occurred in the mountain townships of Hualien County, Nantou County, and Ilan County. A few cases are also reported in Hsinchu and Taitung counties each year. No cases have ever been reported from the mountain townships south of Changhua County[(5)].

The Saint Martin Hospital reported on 9 April 2001 to the Chiayi County Health Bureau a case of bacillary dysentery, a woman of 66 in Tefuyeh Tribe of Dabang Village, Alishan Township. The case developed severe diarrhea at 9 p.m. of 31 March, and was admitted to the Hospital for care during 1-6 April. *S. sonnei* was isolated from her rectal swab. This was the first bacillary dysentery case in Alishan Township in the last ten some years. Staff of the Dabang Health Station soon visited the case on 10-12 April for investigation,

specimen collection, and disinfection of the environment, and to detect any suspects. On 13 April, a team of the Fourth Branch Bureau, the Division of Disease Surveillance and Investigation, the FETP, the Division of Research and Laboratory Testing, all of the Center for Disease Control, and the Chiayi County Health Bureau was on the site for investigation to understand the likely causes of outbreaks and their routes of transmission[6].

Materials and Method

The Villages

Alishan Township consists of five villages (Chungshan, Chungchen, Hsianglin, Shihtzu, Fengshan) and seven mountain townships (Dabang, Shanmei, Leyeh, Laichi, Lichia, Hsinmei, Chashan), all located from 360 to 3,952 meters above sea level. The Township has a population of 6,400 in a large land area of scattered villages. Major products are tea, vegetables, and bamboo shoots, teas being more popular. Organic and chemical fertilizers are used for farming, and very few flies and mosquitoes are noticed. The aborigines of Alishan are primarily the Tzous, now living in two tribes of Tefuyeh and Dabang, both of Dabang Village. The two tribes, 400 and 800 in population, are about three kilometers apart, each with a chief. There in Dabang Village are the Alishan Township Health Station, two private clinics operated by aboriginal physicians (the Wang FF and the Wang CL clinics), one private nursery (with 35 children), and the Dabang Primary School (87 students and teachers). Shanmei Village, 37 kilometers from Dabang, with a population of 627, has one health room, three visits per week by a mobile clinic of the Chiayi Christian Hospital, one private nursery (with 15 children), and the Shanmei Primary School (63 students and teachers). Villagers of both villages drink either spring water or water from the simple water supply tanks. Septic toilets are available in 90% of the households.

Aborigines of Alishan Township generally visit the health station (health room) for care during daytime, and the private clinics at night or on weekends when the health station (health room) is closed. Residents without health insurance or the elderly who only speak the Tzous dialogue will visit the private clinics operated by the aboriginal physicians. The Saint Martin Hospital has a 24-hour medical station in Loyeh Village 12 kilometers from Dabang. Emergency patients visit the medical station first, and are referred to the Hospital when necessary.

The Subjects

Subjects for the investigation were all likely contacts of the first case in Dabang on 17 March and afterwards. Cases were also reported from Shanmei later, persons with diarrhea in Shanmei were also included in the investigation.

The Period

From 17 March (two incubation periods of bacillary dysentery before the onset of the first case on 31 March) to 7 June (two incubation periods after the onset of the last case on 24 May).

Definition of Case

Confirmed case: residents of Dabang Village and Shanmei Village of Alishan Township who had on and after 17 March diarrhea for more than twice a day, and either vomiting, abdominal pain, mucous stools, bloody stools, or fever, and also isolation of *S. sonnei* in rectal swabs.

Suspected case: residents of the two villages who developed infectious gastroenteritis (code 009 by ICD-9) on or after 17 March, or diarrhea of more than twice a day, and either vomiting, abdominal pain, mucous stools, bloody stools, or fever, but no isolation of *S. sonnei* in rectal swabs.

Asymptomatic positive case: residents of the two villages who though did

not develop any symptoms on or after 17 March, but were isolated *S. sonnei* in their rectal swabs.

Survey and Surveillance

To detect cases and suspects in the two villages on and after 17 March, an in-depth interview was given to the first case, a census of Tefuyeh Tribe of Dabang Village was conducted, medical records at all medical care institutions in Alishan Township were reviewed, school attendance and medical records of students of the Dabang and the Shanmei primary schools were reviewed, diarrheal cases and their contacts were followed-up, visited, interviewed, and rectal swabs collected for laboratory testing. Nine surveillance stations for diarrheal cases were set up at the five healthcare institutions in Alishan Township (the Alishan Health Station, the medical station of the Saint Martin Hospital, the Chiayi Christian Hospital, the Wang CL and the Wang FF clinics), two primary schools (the Dabang and the Shanmei primary schools), and two nurseries (the Dabang and the Shanmei nurseries). Cases with two or more diarrhea a day were required to be reported immediately and rectal swabs collected for laboratory testing.

Survey of Environment

Sources of drinking water of Tefuyeh Village and their pipes were surveyed. Water specimens were collected for testing. Household sanitation of cases and sources of drinking water were surveyed, and other environmental specimens were collected for laboratory testing. Environmental sanitation of the two primary schools and two nurseries was surveyed and water specimens were collected for laboratory testing.

Laboratory Testing

Rectal swabs were placed directly in the gram-negative multiplication agar for 4-6 hours, isolated and placed in Hektoen Enteric (HE) agar, SS

(Salmonella-Shigella) agar, and DHL agar under 37℃ for 18-24 hours. For the testing of drinking or environmental water, 1,000 mL was taken. 400 mL of which was added broth for multiplication or filtered with 0.2 μm filter. The filters were then placed in HE, SS and DHL agars for the isolation of pathogenic agents. 200 mL of the water specimens was used for the testing of *E. coli*. HE, SS and DHL agars were studied for pathogenic agents. At least five suspected colonies were picked up (dark green colonies on the HE plates), and inoculated on TSA (Tri-Sugar-Iron), SIM (Sulfite-Indole-Motility), LIM (Lysine- Indole-Motility), Urea, Citrate (Christensen Citrate), and VP (Voges-Proskauer) under 37℃ for 18-24 hours. The biochemical reactions of typical bacillary dysentery bacilli were Alk/A (TSI), Gas (-), H_2S (-), VP (-), Citrate (-), Motility (-), Lysine (-), and Urea (-). If these conditions were met, suspected bacillary dysentery bacilli were picked up and conducted agglutination test with API 20 E kits to decide their subgroups, their types by agglutination test with antiserum, and their bacterial types a, b, c, or x, y by agglutination test with serum.

Epidemiological Investigation

To identify the sources of infection and routes of transmission, and to determine the sources of infection by the testing of human and environmental specimens, charts showing the distribution of dates of onset of all cases and their interpersonal and geographic relations were made. Medical records of diarrhea cases of all five medical care institutions were also reviewed to understand whether diarrhea had always been there in these areas. Villagers were also interviewed intensively to understand the sources of drinking water the cases had always had and their household sanitation (including toilet facilities and drainage).

Disease Control Measures

Community and healthcare resources were consolidated for cleaning up houses and the environment (washing, and disinfecting water tanks and the environment) and health education of the public. Surveillance stations were set up on 13 April at the five medical care institutions, two primary schools and two nurseries for case reporting, specimen collection, and interviewing. Contacts were identified through interviews of cases for investigation, specimen collection, and medication of cases and contacts. Isolation was ordered, if necessary, for confirmed cases.

Results

Epidemiological Investigation

The first case lives with her fourth son, wife, and their children. She was selling breakfast to villagers, at about 25-40 serves a day. The house was complete with toilet and washing facilities. Spring water was boiled for drinking. The environment in general was tidy. The case developed abdominal pain with watery mucous stool at 9 p.m. on 31 March, and bloody stool and fever at 5 a.m. on 1 April. She was admitted to the Saint Martin Hospital for care till 6 April. Her business was tended by her daughter-in-law during her hospitalization. On 8, 10, and 15 April, her daughter-in-law, granddaughter, and son began to develop symptoms and were later confirmed as cases by laboratory testing.

To detect contacts and other cases in the two weeks before the onset of the first case, a census of Tefuyeh Tribe, particularly customers of the breakfast stand, was conducted. Of the 400 some residents in 100 some households in the Tribe, 266 villagers in 99 households had been visited. Medical records at

the five medical care institutions, and school attendance and medical records of students were reviewed. It was found that between 17 and 31 March, two persons met the definition of suspects, though they did not have any contact with the first case, and their laboratory testing was negative. In the period between 1 and 14 April, five suspects were detected; two of them bought breakfast from the first case. One of them was daughter-in-law of the neighbor of the first case. She bought breakfast regularly and took it to the office. She and her son developed symptoms on 2 and 6 April, though both were tested negative. Another breakfast purchaser, a 72 year-old woman, developed symptoms on the evening of 13 April, visited the Wang CL clinic on 14 April, and was tested positive. Her daughter and a six-month old girl baby under care developed symptoms on 6 April, though both were tested negative.

By 4 June, 62 cases had been reported by the five medical care institutions (25 by the Alishan Health Station, 9 by the medical station of the Saint Martin Hospital, 18 by the Chiayi Christian Hospital, 8 by the Wang CL Clinic, and 2 by the Wang FF Clinic). Of these 62 diarrheal cases, 14 were students of the Dabang Primary School (began to develop symptoms on 19 April), seven were students of the Shanmei Primary School (began developing symptoms on 24 April), four were children of the Shanmei Nursery (began developing symptoms on 22 April), and one was a child of the Dabang Nursery (developed symptoms on 20 May). Ten of them were confirmed by laboratory testing as cases of bacillary dysentery (5 of the medical station of the Saint Martin Hospital, one of the Chiayi Christian Hospital, one of the Dabang Health Station, and three of the Wang CL Clinic).

Between 10 April and 28 May, 277 contacts had been visited and specimens collected for laboratory testing (83 from the Dabang Primary School,

53 from the Shanmei Primary School, 35 from the Dabang Nursery, and 16 from the Shanmei Nursery) to find one asymtomatic positive case and 20 suspects who had had symptoms before. Of the 20 suspects, 15 were found to be confirmed cases. In the process of disease survey, starting with the first confirmed case in Dabang Village on 9 April till 4 June, 82 cases had been detected (10 confirmed cases, one asymptomatic positive case and 34 suspects in Dabang, and 14 confirmed cases and 23 suspects in Shanmei).

The first case of Dabang had the first onset on 31 March. The last case, also from Dabang, had onset on 24 May. The first case in Shanmei on 22 April was a three-year old girl of the Shanmei Nursery. Her grandmother was sister of the first case of Dabang and had contact with the case at her home. All cases were associated in terms of time sequence (Figure 1), personal contact and geography (Figure 2). Of the houses of the suspects, one in Shanmei was densely inhabited by three generations of 12 members in a house of less than 20 pings (with only one toilet). Eight of them had developed symptoms, and four were confirmed cases. In the rest houses, each was inhabited by 2-6 persons.

Results of the Environmental Survey

Spring water in Tefuyeh Tribe comes from the Secret Valley some 8 kilometers away. Water is piped up to three 4-5 ton simple water tanks on the hill some 300 meters high, and further to each household. Pipes were in fair conditions, and not contaminated by wastes. Few families in either Dabang or Shanmei farmed poultry. Tea, vegetable and bamboo shoot gardens were all around. No toilet or washing facilities was in the gardens. Sanitation around the houses was fair. Each house was equipped with septic tank, water (spring water) and power supply. Mosquitoes and flies were few. The whole village

had a cleanup every Saturday morning. Wastes were collected regularly three times a week. Spring water was boiled for drinking. Sewers were not covered. The Dabang Primary School, Shanmei Primary School, Shanmei Nursery and Dabang Nursery were all spacious and clean (fewer students in most mountain area schools, only about ten in a class), and complete with toilet and washing facilities. Spring water was used.

Results of Laboratory Testing

A total of 49 environmental specimens were collected. Of the 35 from Dabang, coliform was isolated in three of the eight environmental specimens collected from the water tanks; four in the 16 from household water supply (five from trans-tubes and 11 from water); none of the six collected from schools; and no pathogenic agents were isolated in the three specimens from household sewers (two trans-tubes and one water). No pathogens were isolated in the two trans-tube specimens from toilets. Of the 14 environmental specimens from Shanmei, no pathogens were isolated in the three household water specimens (one trans-tube and two water); and coliform was isolated in three of the six water specimens collected from the school (the Shanmei Nursery). Five specimens were collected in three times from the No. 4 toilet of Shanmei (*S. sonnei* was isolated in the first collection; and two follow-up inspections and testing on 8-9 May after disinfection were negative). A total of 408 human specimens were collected from 338 persons. In 25 of them, *S. sonnei* was isolated, two under three years of age, 10 in the 4-6 age group (nine in the Shanmei Nursery and one in the Dabang Nursery), six in the 21-65 age group, and four of 65 and above. Sensitivity test against drug showed that *S. sonnei* was sensitive to all antibiotics such as ampicillin, ceftriaxone, ciprofloxacin, chloramphnicol, trimethoprim/ sulfamethoxazole, and gentamicin.

Results of Epidemiological Investigation

The source of infection, by the laboratory testing of human and environmental specimens, was decided to be *S. sonnei*. From the distribution of dates of onset (Figure 1) and interpersonal and geographic relations of cases (Figure 2), it was concluded that the outbreaks were transmitted by person-to-person contacts.

Effects of the Control Measures

The nine surveillance stations made perfect and prompt reporting. The five medical care institutions also helped in the laboratory testing. Outbreaks were soon brought under control. An all-out cleanup was carried out in both villages. Water tanks were cleaned up under the supervision of the health station. Houses and schools of suspects were disinfected. In the period between 17 April and 10 May, 35 meetings for health education had been held for 1,290 participants. Educational materials had been distributed to schools, posted on bulletin boards, and given to the public to alert them to the prevention of bacillary dysentery.

In the medication of the contacts, 43 of the 44 in Shanmei were given co-trimoxazol (Baktar) twice a day for seven days, and the rest one was given ampicillin three times a day for seven days. 16 in Dabang were also given co-trimoxazol. 18 confirmed cases were placed under isolation care at the Saint Martin Hospital. The breakfast stand of the first case, and four more confirmed cases later, was suspended for four weeks. The Shanmei Nursery was closed for two days.

Discussion and Conclusion

The incubation period of bacillary dysentery ranges from several hours to seven days, averaging 1-3 days[8]. The investigation period was from two incubation periods each before and after the detection of the first case

(17 March to 7 June). During this period, 82 cases had been detected, including 24 confirmed cases and one asymptomatic positive case. The median age of the cases was 12 years, ranging from two months old to 86 years. The mode was 11 years.

Bacillary dysentery is transmitted primarily via four routes[3]. The first route is by person-to-person contact through hands and through either direct or indirect oral-fecal transmission. It can be transmitted by water. Some outbreaks caused by contaminated swimming pool water or fountain water have been reported elsewhere[9]. It can also be transmitted by contaminated food, and by flies. The first case in Dabang became ill on 31 March. The first case in Shanmei became ill on 22 April. Her grandmother is sister of the first case of Dabang and had visited her several times at her home. By environmental survey, it was noted that all cases were related interpersonally, by time sequences and geographically. It could therefore be concluded that the present bacillary dysentery outbreaks were caused by person-to-person contacts.

Literature shows that young children, children in nurseries, care centers and kindergartens, and people in crowded places are the high-risk groups of bacillary dysentery[2,10]. Children and the elderly of poorer immunity are more susceptible to bacillary dysentery[8]. The same trend was noticed in the present investigation. Of the 15 children in the Shanmei Nursery, 9 were infected, all confirmed cases, at an incidence of 60.0%. A household in Shanmei, overcrowded with 12 people in a small house of less than 20 pings, 8 of them had symptoms of bacillary dysentery, at a high incidence of 66.7%. By the age distribution of cases (Table 1), 30.5% of the cases were in the 1-6 age group, 24.4% in the 7-12 age group, and 9.8% in the 65 and above age group, accounting altogether for 64.7% of all cases. By the age

distribution of confirmed cases, 48.0% were in the 1-6 age group, 12.0% in the 7-12 age group, and 16.0% in the 65 and above age group, accounting altogether for 76.0% of all.

Disease and epidemiological surveys in the past were always conducted after cases had been reported. The present investigation was different in that it immediately took active disease surveillance and control measures soon after the reporting of the first case. Cases of diarrhea and fever were managed as suspects of bacillary dysentery, and specimens were collected from them for testing. At the same time, investigation was conducted and control measures taken. In the 82 cases, only one, the first case, was reported, the rest 24 positive cases and 57 suspects were detected through active surveillance and disease surveys. As soon as suspected were detected, they were given medication or care under isolation to effectively eliminate the sources of infection. Action was also taken to clean up the environment, for disinfection and health education of the public to solicit both the attention and active participation of the residents. School nurses, nurses of the health station, and physicians of the two private clinics were fully involved in case reporting to facilitate the execution of the control measures. Of the 24 confirmed cases, 16 had been detected through the active follow-up and visits of 277 contacts. Active disease survey has obviously an important role to play in disease control.

Through review of medical records of diarrheal patients between January 2000 and April 2001 at the five medical care institutions, the Alishan Health Station, the Wang CL Clinic, the Wang FF Clinic, the medical station of the Saint Martin Hospital, and the Chiayi Christian Hospital, and interviews with villagers, it was noted that diarrhea had always been there in the past. Villagers thought very little of diarrhea, and

patients often recovered in a day or two. Serious cases were treated with herbs. The actual number of diarrheal cases should have exceeded the number of cases medically cared. Some reports mentioned that after recovery from bacillary dysentery, though there would be in blood antibodies against *Shigella,* they were incapable of preventing the recurrence of bacillary dysentery[8]. Surveys of all contacts with the first case in the two weeks before the onset through census and in-depth interviews of all villagers found that many villagers either could not recall for some time or did not remember any incident of diarrhea. They had hard time to remember whether they had any contacts with anyone at any time. Some were reluctant to report for fear that they could cause some nuisance to others. Some were embarrassed to acknowledge any such contacts. These and others posed some obstacles to the tracing of the sources of bacillary dysentery infection, and also to the detection of suspects as well. By the medical records at the medical care institutions, it was obvious that bacillary dysentery had been in existence in this area for long, though in most cases, it was treated as gastroenteritis, and was less noticed. The whereabouts of the sources of infection of the present outbreaks remained therefore to be studied further.

The *S. sonnei* of previous bacillary dysentery outbreaks in the northern, eastern and central parts of Taiwan was relatively resistant to nalidixic acid, Baktar (co-trimoxazol), or ampicillin. These three antibiotics could not therefore be used either for treatment or prevention. The *S. sonnei* of the present outbreaks was not resistant to all antibiotics used for sensitivity test. Either Bakar or ampicillin was most effective for preventive medication. Dabang Village is an isolated village, antibiotics are rarely used for the treatment of diarrhea. Instead, antidiarrheals are used. Whether the *S. sonnei* of the outbreaks in Dabang Village of Alishan has the same features

as *S. sonnei* of the Taiwan Area remains to be studied further.

Recommendations

It was through the joint efforts of persons concerned at all levels for "prompt and professional disease control" that active disease surveillance and control measures could have been taken to control the outbreaks in no time. The consolidated efforts of the community as a whole, and the active participation of schools, the community and medical care institutions in disease surveillance, reporting and specimen collection also helped a great deal in the effective control and management of suspects. By this experience, it is suggested that disease control in the future should not wait for medical care institutions to report cases after their confirmation, but should begin control measures soon after the detection of suspected bacillary dysentery cases. In other words, symptom surveillance should replace disease surveillance.

Though spring water was not the cause of the present outbreaks, coliform was detected in the water tanks of both villages, and in the water used by kindergartens and households. The safety of water in these areas needs improvement. It is suggested that villagers of Dabang and Shanmei regularly clean up and disinfect their water tanks, install chlorinating facilities for the regular chlorinating of water to improve the quality and safety of drinking water.

The age distribution of cases in the present investigation corresponds to studies reported elsewhere. Young children and children in nurseries are the high-risk groups. In the future campaigns for the prevention and control of bacillary dysentery, pre-school children should be the priority groups for health education. Adults in mountain areas are always away from home for work; children are often tended by the elderly of the family.

The elderly are often, through care of young children and because of poorer personal hygiene, infected with baccilary dysentery. Health education of the elderly should not be overlooked.

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Figure 1. Distribution of Dates of Onset for All Shigellosis Cases in Dabang and Shanmei Villiages

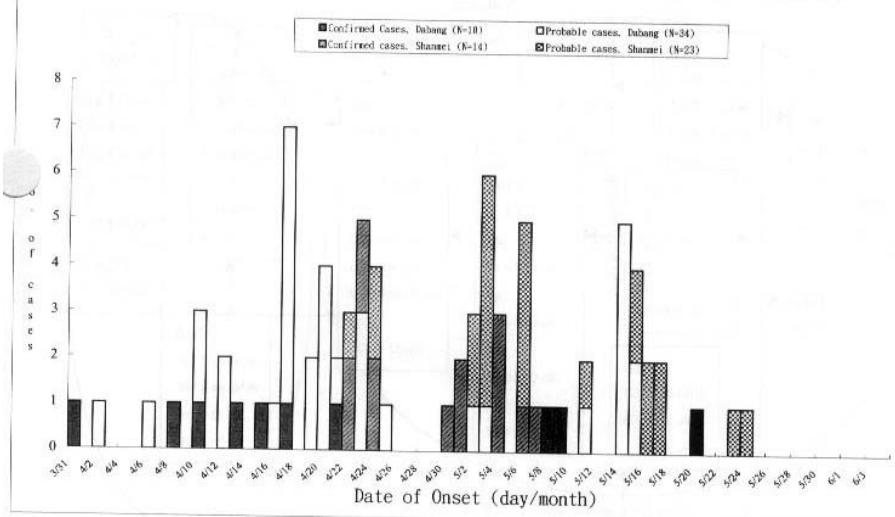

Figure 2. Interpersonal and Geographic Relationships of Cases in Dabang and Shanmei Villages

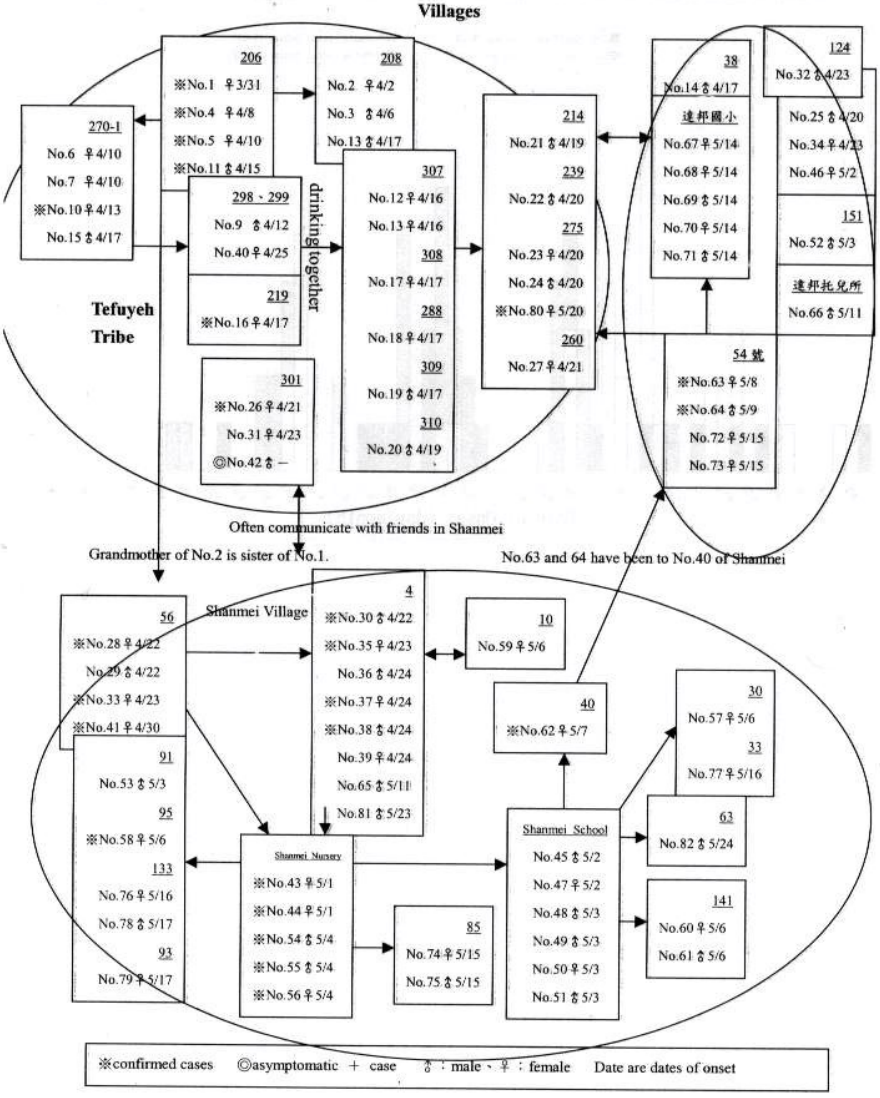

Table 1. Age Distribution of Shigellosis Cases in Dabang and Shanmei Villages

Age	<1	1-3	4-6	7-12	13-20	21-65	>65	Total
Confirmed No. (%)	3 (3.7)	7 (8.5)	15 (18.3)	20 (24.4)	5 (6.1)	24 (29.3)	8 (9.8)	82 (100.0)
Positive No. (%)	0 (0.0)	2 (8.0)	10 (40.0)	3 (12.0)	0 (0.0)	6 (24.0)	4 (16.0)	25 (100.0)