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Epidemiological Investigation of a Shigellosis Outbreak At a Mental Institution in Taoyuan County

Abstract

Shigella is the main infectious agent of Shigellosis. Estimate is that, worldwide, excluding the mainland China, around 140 million children under five years are infected each year, causing 576,000 deaths[14]. Serotypes *S. sonnei* and *S. flexneri* are common in Taiwan. *S. flexneri* is found more often in outbreaks at mental institutions or nursing homes; whereas *S. sonnei* is seen more often in schools or communities through contaminated underground water[24,25] . An outbreak of dysentery at a mental institution was reported in September 1998, the climax being on 15 September. Laboratory testing of rectal swabs collected from patients with symptoms confirmed that the incident was *S. flexneri* infection. In May 1997, the institution had a similar Shigellosis infection. This outbreak should be the second infection. An epidemiological investigation was conducted immediately to understand the mode of transmission and the risk factors. The overall attack rate was 28.1%. No clustering by room was noticed. Residual chlorine in water for hand washing at the toilet was zeros. The common source of the outbreak was considered to be the contaminated underground water.

Introduction

Shigellosis (bacillary dysentery) is a common acute bacterial disease of the intestine. Main symptoms are diarrhea (watery), fever, abdominal pain, nausea, vomiting, and tenesmus. Incubation period is 2-5 days. Symptoms will last for 3-5 days. The serious watery diarrhea gives the infection the name of dysentery. The symptom was already mentioned in the Old Testament and was thought to be associated with wars. In 1684, T. Willie mentioned that “the disease attacks the intestines; its symptoms

are milder than those of plague; it continues for years and causes many deaths." In 1898, Dr. Shiga successfully isolated the strains, and they were named *Shigella dysenteriae*. Subsequently, three more serotypes, *S. flexneri*, *S. boydi*, and *S. sonnei*, were isolated[1].

Outbreaks of Shigellosis are closely associated with higher population density, overcrowding, poor sanitary facilities, and the high sensitivity of the microbe. Inter-personal contact, therefore, is an important route of transmission. Outbreaks are often caused by poor sanitary facilities, inadequate water supply, and use of contaminated underground water[2-4].

Specific serotypes (primarily *S. flexneri*) are found in day care centers[5,6], nurseries, mental institutions[7], rehabilitation centers for chronic diseases[8], or institutions for the disabled. For overcrowding and poor health behaviors, Shigellosis has always been an important public health issue[9-11].

The Background

On 9 September 1998, four inmates of a mental institution had developed symptoms such as fever, vomiting, and diarrhea. On 10 September, the nurse of the institution took five patients (an additional one) to the Pateh Health Station (also the Pateh Group Practice Center) for treatment. On 11 September, five more new patients; on 14 September, 10 patients (including three former patients); and on 15 September, five more new patients were treated. Major symptoms were high fever, diarrhea, and vomiting. They were given amoxicillin 250 mg four times a day. On 16 September, when nine more patients (including one former patient) were brought in for treatment, the health station was alerted and reported to the health bureau immediately. On suspicion of a dysentery epidemic, the health bureau immediately took rectal swabs from 26 inmates of the new building of the institution at 15:30 of the day. As there was a dysentery outbreak at the institution a year before in May 1997, though only 14 inmates were infected then, this incident was considered the second infection. To prevent spread, Pipera (Pipemidic Acid Trihydrate 235.6 mg/tablet) twice a day for five days was given to all inmates as prophylactic. On 21 September, the FETP, the National Quarantine Service of the Department of Health, the Taoyuan County Health Bureau, and the Pateh Health Station visited the institution for field investigation to understand the mode of transmission and the risk factors, and to take immediate and effective measures to contain the infection.

Materials and Method

1. Records of medication and confirmation of cases

   Records of medication were obtained from the institution to understand the conditions and medication of the inmates.
2. Questionnaire survey

   On 21 September, all faculty members, inmates and employees of the institution were given a structured questionnaire. The questionnaire contained items on personal background information, place of residence, status of infection, symptoms, date of onset, medical treatment, medication, and others. Most inmates were mentally retarded, caretakers filled in their questionnaires. Foreign

caretakers were helped in the translation of the questionnaire. The administrative staff filled in their own questionnaires.

3. Definition of case

A case was defined as one who had, in the period between 20 August and 20 September 1998, diarrhea at least twice a day and one of the following symptoms: fever (38℃ and above), abdominal pain, vomiting, nausea, tenesmus, mucus or pus in stools; or one who had been confirmed by laboratory testing bacillary dysentery positive. The rest inmates were held as controls.

4. Survey of the environment

A plan of the institution was drawn as Figure 1. The institution was tidy, and was separated from other buildings by fences. There were one old building and two new buildings. Inmates lived in these buildings. During daytime, they either did some manual work or played around the yard in the old building. Inmates were seriously retarded. There were 149 faculty members and inmates (excluding one who had been on long leave since August) living in the first, second and third floors of the old building, and first, second, fourth and fifth floors of the new buildings. There were 11 caretakers, 12 foreign caretakers, 7 administrative staff, 25 children under day care, and 5 day care teachers.

5. Collection of specimens

1) human specimens

At 15:30 on 16 September, the Health Bureau collected rectal swabs from 26 inmates with symptoms. The specimens were sent to the Division of Bacteriology of the National Institute of Preventive Medicine for laboratory testing. Medicine was given to all inmates on the same day. Medicine was given to caretakers on 18 September. Three days after the completion of medication (24 September), in a follow-up, 171 specimens were collected from all 148 inmates and 23 caretakers.

Specimens were placed in cary-blair transport medium for transportation to the laboratories. They were tested following the standard operating procedure for *Shigella*. Specimens were swabbed on H.E. (Hektoen-Enteric) agar, *S.S.* (*Salmonella shigella*) agar, or DHL agar for culture for 18-24 hours under 37℃. Suspected colonies were picked up and inoculated on identification media such as TSI, SIM, LIM, UREA, or Citrate VP for identification. They were then tested by serological testing to confirm their serotypes and sero subtypes[12,13].

2) Environmental specimens

On 16 September, the Health Bureau collected from the institution seven environmental specimens (of outlets of sewage, toilets, desks and chairs, floors of toilets, hand-washing basins in the old building, hands of drinking fountains, and water from drinking fountains). They were sent to the National Institute of Preventive Medicine for laboratory testing. It was likely that underground water was still used, the Health Bureau collected on 25 September 1,000 ml of water each from the four water towers of the new and old buildings for laboratory

testing by the National Institute of Preventive Medicine. Each water specimen was divided into three parts. Each of the two 400 ml parts was either added broth agar for multiplication or filtered for culture for *Shigella*[12,13].

6. Data processing and analysis

Data were keyed-in with Epi-info 6.02v and confirmed for accuracy. They were analyzed with Epi-info soft. For the 95% confidence intervals of relative odds ratios, Taylor's series was used.

Result

1. Questionnaire survey

208 copies of a structured questionnaire were distributed to all inmates, teachers, caretakers and administrative staff of the institution. The return rate was 100% : 148 copies from inmates, 11 from local caretakers, 12 from foreign caretakers, 25 from children of day the care center, 5 from teachers of the day care center, and 7 from administrative staff. The 37 children, teachers and administrative staff of the day care center had their own drinking and eating facilities, they were in little contact with the inmates, and none of them had developed any clinical symptoms, they were excluded from statistical analysis. The rest 171 persons were statistically analyzed.

Of them, 48 met the criteria of a case, giving an attack rate of 28.1% (48/171), 32 males and 16 females. No statistically significant gender difference in the attack rate was noted. Of the patients, 41 were mental inmates, giving an attack rate of inmates of 27.7%. Seven of them were caretakers, giving an attack rate of caretakers of 30.4%. No statistically significant difference in the attack rates between inmates and caretakers was noted. Of the infected caretakers, four were natives, giving an attack rate of 36.4%; and three were foreigners, giving an attack rate of 25%. No statistically significant difference in the attack rates between nationals and foreigners was noted. The infected inmates lived on all floors of the new and the old buildings (see Figure 1). The number of inmates in each room varied, no statistically significant difference between the number of occupants in each room and the attack rates was noted. It seemed that infection was not associated with the number of occupants in each room (Table 1).

Of the caretakers (Table 2), none of the inmates cared by the foreign caretakers who became ill on 20 August met the criteria of a case. The rest caretakers became ill after the inmates were infected. Caretaker No. 45 cared for nine inmates. Though the rectal swabs of six of them were found positive, only two developed symptoms, the rest were of inapparent infection. It seemed that caretakers did not infect inmates.

Of the 48 who met the criteria of a case, seven were without symptoms, giving an inapparent infection rate of 14.6% (7/48). Major symptoms were fever (22 persons, 53.7%), abdominal pain (12, 29.3%), vomiting or nausea (6, 14.6%), tenesmus (4, 9.8%), and blood in stool (10, 24.4%). 29 of the 41 with symptoms were medically treated, giving a treatment rate of 70.7%; though medication rate was as high as 95.1% (39/41). The two who did not take any medicine took the prophylactics. The average time between onset of symptoms and medical care was

one day. Symptoms on average lasted for three days to as long as 14 days, the median being three days.

The epidemiological curve of the 41 with symptoms is shown in Figure 2. Two of them, when filling in the questionnaire, said they had not developed any symptoms. Medical records showed, however, they were treated for diarrhea on 31 August with antibiotics and antidirrheals. *S. flexneri* was also isolated in their laboratory testing. These two were included for study, though not analyzed for their symptoms. The index case became ill on 20 August. Two became ill on 31 August, and two more on 3 September. From 7 September and on, patients occurred practically every day, reaching a climax on 14 and 15 September. On 16 September, the Health Bureau distributed piperamic acid as prophylactic. Only one inmate became ill on 16 September. No infections of the inmates were reported ever since. Prophylactics were not given to caretakers yet till 19 September, one foreign caretaker became ill on 18 September.

2. Environmental survey

The institution (Figure 1) was tidy. It was separated from other buildings by fences. There were one old building and two newly renovated buildings. Inmates lived in these buildings. During daytime, they either did some manual work or played around the yard in the old building. Distribution of cases by room is also shown in Figure 1.

The kitchen was in the old building, only one meter away from the public toilet. Since the outbreak in May 1997, the entrance to the kitchen had been moved to the other side of the kitchen away from the toilet. Food was prepared under the supervision of one cook and some foreign caretakers with the help of some inmates. None of the cook or the foreign caretakers met the criteria of a case. Facilities in the kitchen were in good conditions. There were a high-pressure sterilizer and a large freezer.

Both tap water and underground water were used. There were one deep well and one shallow well. The deep well was located in front of the new building and was only for fish raising. The shallow well was in the old building between the kitchen/dining room and the toilet, only two meters away from the toilet. Before May 1997, this well had been used only for fire-prevention and laundry. At the time of a dysentery outbreak in May 1997, No. 6 red coloring was used to check any leak. This well had been covered and used for fire-prevention only. Though the institution maintained that the well had been covered since the outbreak of last year, two unidentified PVC pipes were found to come out of the well. Test on 21 September showed residual chlorine of 0.25 ppm in the water of the new buildings. No water came out from the taps of the washing basin near the toilet. Inmates either did not wash hands after toilet or washed their hands at basins some distance away. However, when the taps were turned on two hours later, water came out. The residual chlorine then was 0.25 ppm. The residual chlorine of the water of the drinking fountains was

also 0.25 ppm. On 24 September, the water supply system of the institution was investigated together with the local public water works. It was found that the water tower at the old building was supplied only through a one-inch pipe. The water was certainly not sufficient to meet the demands of the inmates. Water supply lines were illegally connected from outside, and water was pumped up to the three water towers up on the old buildings and controlled and supplied by switches. Water consumption records (Table 3) showed monthly consumption ranging from 882 to 1,307 degrees a month. Water consumption during summertime in July and August was not necessarily higher. The evidence indicated that underground water was still in use. Tests of the day showed residual chlorine of 0 at the washing basin near the toilet, and 0.25 ppm of the tap water in the kitchen.

Bathing facilities were available both in the old and the new buildings. There were two bathing rooms at each end of the old building, one near the drinking fountain, the other inside the toilet. One meter away from the toilet was a washing basin, often without running water. Feces were seen on toilet floors. A ditch along the toilet was close to the shallow well. The distance between the toilet and the shallow well was two meters. Septic tanks were located outside the fence and were 5-6 meters away from the well.

3. Laboratory testing

1) human specimens

From the 26 rectal swabs sent in for testing on 16 September, 11 were found to be bacillary dysentery positive of serotype *S. flexneri 2a*. Of the rectal swabs of all caretakers and inmates sent in on 24 September after prophylactics, one was found positive. This inmate was then given nalidixic acid under the supervision of the nurse. He was tested negative five days later. Drug resistance test conducted by the Division of Bacteriology of the National Institute of Preventive Medicine on 17 December showed that *S. flexneri 2a* was resistant to ampicillin, oxacillin, trimethoprim-sulfamethoxazole, tetracyclin, and penicillin G. Only nalidixic acid, cefixime, and cephalothin were effective.

2) Environmental specimens

The seven environmental specimens collected from outlets of sewage, toilet seats, desks and chairs, toilet floors, washing basin at the old building, hands of drinking fountains, and water from drinking fountains, and water specimens from the four water towers were all tested negative.

Discussion

Shigella is a major infectious agent of diarrhea. In the early 20th century, *Shigella dysenteriae*, or *Shigella*, was the major cause of Shigellosis. In Japan, 90,000 people have been infected, with 25% deaths. Worldwide and not including the mainland China, about 140 million children under five years are infected each year, resulting in 576,000 deaths[14]. The incidence and prevalence of bacillary dysentery vary from areas and ages. In a cohort follow-up study in Guatemala, 21% of the newborns had diarrhea, and

Bacillary dysenteriae was the major cause. Incidence also increases with age. In India for instance, incidence increases from 0.7% of the newborns to 7.1-8.5% at the age of three. In the US and other developed countries, bacillary dysentery is still a major infectious agent of the disease of the intestine. In 1993 in the US, 32,198 cases had been reported through passive surveillance system to the US CDC. Of them, 91% were *S. sonnei*, and 7% *S. flexneri*[15]. By serotypes, in Bengal in 1994, 48.6% were *S. flexneri*[16]; and in New Zealand in 1996, 23% were *S. flexneri*[18]. In the US, though S. sonnei was more prevalent[15], on Indian reservations with a 3.6 times higher prevalence, the major serotype was *S. flexneri*[18]. In a two-year follow-up study in one mental institution, bacillary dysentery patients became chronic carriers, they developed symptoms again under poorer health conditions, and discharged pathogenic agents in feces for long time. The infection at the institution continued for more than two years. Studies have shown that 10.2% of the cases will have at least one positive testing; and, at the time of first culture, 46% are with symptoms[19]. Day care centers often have higher incidence. In a 19-month follow-up study of day care center children in Texas, the incidence was 6,689/10,000. The infection also spread to families at the rate of 26 to 24%[20]. In eight traditional Jewish communities in North America, the same agent though had been in existence for as long as two years, it never spread to other neighboring non- Jewish communities[21]. Interpersonal contacts seem to play an important role in the transmission. Dysentery infection is universal, though the degree varies with health behaviors and sanitary facilities. In a report, the outbreak of bacillary dysentery at a mental institution with an attack rate as high as 63% was considered to have been caused by interpersonal contacts[7].

S. sonnei and *S. flexneri* are common in Taiwan[22,23]. *S. flexneri* is found more often in outbreaks at mental institutions or nursing homes[22]; whereas *S. sonnei* is seen more often in schools and communities[24-26]. Most infections are caused primarily by contaminated underground water affecting many people at one time. The dysentery outbreak at a private school in Taichung in September and October 1993[25], and another outbreak at a primary school in Taoyuan in November 1995 with an attack rate of 29.7%, are some cases in point.

The attack rate of the present incident was 28.1%. The first case that met the criteria of a case was a foreign caretaker who became ill on 20 August. No cases were reported in the next ten days. On 31 August, two inmates became ill. They failed to mention the infection on the questionnaire. Medical records showed, however, that they were treated at the health center of the institution for diarrhea on 31 August. One of them had been away from the institution for two weeks until 30 August. Findings of their laboratory testing were all positive. On 3 September, two more inmates became ill. They and others were given chloramphenicol and symptom-oriented medicines at the health center of the institution. Ever since, except the weekend (12-13 September), the health center treated 4-11 patients a day. The epidemiological curve shows that the infection reached a climax on 14-15 September. There seemed to have been one common source of infection. On 16 September, upon report of the health station, the

Health Bureau visited the institution for the collection of rectal swabs and administration of prophylactic. One inmate became ill on 16 September before the prophylactic. One foreign caretaker became ill on 18 September before prophylactic was given to caretakers. No cases of caretakers were reported ever since. Interpersonal contact as a mode of transmission could be eliminated as per Table 2. The institution denied the use of underground water. However, the water consumption records, the use of underground water as detected by the public water works, the residual chlorine tested the second time being 0, and other facts all indicated that the water of the washing basin was contaminated by underground water. No *bacillary dysenteriae* was detected in the underground water. The collection of water specimens was made almost one week after the outbreak, the institution was on alert from this and the last outbreaks a year ago, some measures could have been taken. In fact, some traces of bleaching powder were noticed in the well to indicate the use of bleaching powder and also the use of underground water. Water supply could have been switched to tap water. Only specimens of tap water were then collected. Inspection of the washing basin conducted together with the public water works on 24 September showed the residual chlorine being 0. This was an indication of the use of underground water. The outbreak of last year was confirmed to have been caused by the contamination of the underground water. During this period, the wells had been covered. Government regulations are that underground water can only be used for fire-prevention. However, all facts indicated that underground water was still used by the institution. The common source of infection of the present outbreak should be the contaminated underground water.

Of the 208 cases, none of the 25 children and five teachers of the day care center, and seven administrative staff of the new buildings became ill, as they had their own drinking fountains in the new buildings or they brought their own drinking water. The average age of the 25 children of the day care center was 12.5 years (ranging from 6 to 21), any infection would have spread rapidly. That none of the children, the administrative staff and teachers became ill, though they were in close contact, was perhaps because of better personal hygiene and also the use of separate drinking fountains.

The inmates are mentally retarded. They have difficulties in communication. Diarrhea was used as an important criterion of a case in this incident, because most positive cases had indicated on the questionnaire diarrhea as one major symptom, and some suspected cases had been treated for diarrhea at the health center of the institution during the infection period. To prevent the spread of infection, institutions should be more alert to a sudden increase of diarrhea. It was not a good practice of the institution to give chloramphenicol to diarrhea patients, as the agent was later found resistant to the drug. These practice though could reduce symptoms, could not prevent the discharge of pathogenic agents, and would make the agents drug-resistant. The small size of specimens collected by the Health Bureau was also one of the reasons that made the investigation more difficult. To understand the scale of the infection, and to identify real

risk factors, specimens should be collected from all patients with diarrhea during this period.

Literature shows that contaminated underground water is not the only cause of water-borne infection. Swimming[27,28] and surfing in contaminated water, flying kites around the area, and even rinsing with underground water can also lead to infection[29]. As only 10-200 bacteria are enough to induce infection, any contact with contaminated water is likely to result in infection.

In South Africa in 1997 at a mental institution, a *S. dysenteriae* type one infection occurred, with 40% deaths[30]. In laboratories, the attack rate can be as high as 22%[31]. In Rwanda, *S. flexneri* is the leading cause of infection[32]. In Canada, because of crowded housing, lack of running water, and inadequate sewage disposal, incidence of dysentery on Indian reservations is 29 times higher, with 12 times higher hospitalization rate[3]. In Turkey, *S. flexneri* is the leading cause, accounting for 82.9% in 1995[33]. In Israel, the number of serotype *S. sonnei* infections had increased from 60% in 1986 to 91% in 1991, primarily because of drug resistance[34]. The number of drug resistance strains, particularly to ampicillin, trimethoprimsulphamethorazole (SXT) and TC, has increased everywhere[35]. In New Zealand, *S. flexneri* is 57% drug-resistant to SXT, and 30.8% resistant to both ampicillin and SXT[17]. A children's hospital in Japan noticed a general increase in serotypes resistant to drugs during the 1987 to 1994 period; resistance to SXT for instance, had increased from 27% in 1990 to 66% in 1994; though resistance to ampicillin had decreased from 81% in 1987 to 32% in 1993. *S. flexneri* is in general more drug-resistant[35].

Cases treated at the group practice center were not given antibiotics for the first two days. Amoxicillin (250 mg) four times a day was given on 14 September. Amoxicillin was not effective as it was quickly absorbed by the small intestines. Ampicillin was found drug-resistant. The chlormphenicol given by the institution though was not tested for drug resistance, it had been proved elsewhere that it was drug resistant, particularly type 2 *S. flexneri*[36]. The Pipera (pipemidic acid trihydrate 235.6 mg), two tablets a time, four times a day for five days given by the institution was not drug-resistant, it was effective to control the infection. None of the caretakers became ill after taking the prophylactic on 19 September. Only one inmate tested positive in all specimens collected on 24 September after the prophylactic. This inmate did not follow order; he was given medicine under the supervision of the nurse. He tested negative afterwards. As specimens from caretakers were collected after prophylactic, there was no way to identify the source of infection and the actual number of victims. One foreign caretaker left the country for one week and returned on 19 August. She developed diarrhea on 20 August, was given chloramphenicol and anti-diarrhea medicines for two days, and the symptoms disappeared. No rectal swab was taken from her before prophylactic, there was no way to prove if she had brought in the infection.

Specimens collected on 16 September were not from all inmates and teachers or from all suspects. Of the 26 specimens collected on 16 September, 11 were tested positive; of them, five were with symptoms. Though two of them did not mention

any symptoms on the questionnaire, medical records showed that they were treated for diarrhea on 31 August, their laboratory testing was positive. The carrier rate thus was as high as 23.1% (6/26). Since specimens were not collected randomly nor from some specific patients, whether a conclusion could be reached was debatable. It was arguable whether the carrier rate was 6/26 or 7/48. 83.3% of them were with symptoms and laboratory tested positive (5/6). One case though developed symptoms and yet was laboratory tested negative became ill on 11 September and was treated immediately. The symptoms disappeared on 13 September. Rectal specimen was collected from him on 16 September. Detection rate was generally lower in rectal swabs than in fresh feces. The medium used, Cary-Blair medium, gave a medium survival rate. The patient had been medicated, symptoms had already disappeared at the time of specimen collection. The laboratory testing was likely to be negative. As specimens were not generally collected before prophylactic, the attack rate was likely to be underestimated, the number of patients should have been more.

Limitations of Investigation

Inmates were seriously retarded, direct communication with them was difficult. 12 of the 23 caretakers were foreign, their answers on the questionnaire might not be correct. These were limitations in the use of structured questionnaires. Attempts were made to overcome the limitations by referring to information and records of the health center of the institution for support.

No general collection of specimens was made before prophylactic. Though the positive rate was 42.3% (11/26), whether the carrier rate was 23.1% (6/26), 14.9% (7/48), or 7/171 could not be decided.

Obstructions and non-cooperation on the part of the institution also made the investigation more difficult.

Information at the health center of the institution and medical records at the local health station was too simple. No recordings of symptoms but medicines were made.

Recommendations

1. Health education on dysentery should be given to nurses and teachers. Caretakers should be told to wash hands before and after care taking. Inmates should be supervised to wash hands before meals and after toilet. Soaps should be made available.
2. The use of underground water was suspected (residual chlorine being 0). Institutions should be strictly forbidden to use underground water. Underground water should only be used for toilet.
3. Diseases spread more readily in care institutions. New inmates, newly recruited foreign caretakers, and foreign caretakers returning from vacation, with the assistance of the health bureau, should be screened for dysentery, and isolation until the testing is negative.
4. For the effective control of infections, medical care institutions should be instructed

to report immediately to authorities concerned in the case of any suspected group diarrhea at care institutions, nursing homes, or day care centers.

5. Health bureaus should, at time of outbreaks, collect specimens before prophylactic or general disinfection. Epidemiological investigation can be more comprehensive, and pathogenic factors can thus be identified for more effective prevention and control.

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Table 1. Attack Rates by Number of Occupants in a Room

No. of Person	Attack Rate	Relative Odds Ratio	95% Confidence Interval
1	50.0%	1.00	
2	22.2%	2.25	0.61- 8.31
3	33.3%	1.50	0.46- 4.87
4	12.5%	4.00	0.75-20.52
5	22.5%	2.22	0.71- 6.922
7	35.7%	1.40	0.42- 4.68
8	37.5%	1.33	0.44- 4.04
9	11.1%	4.50	0.56-36.44
14	21.4%	2.33	0.57- 9.00

Table 2. Distribution of Cases by Major Caretakers

Caretaker	No. cared	No. Cases	Caretaker Infected	Attack Rate (%)	Onset Date of Index Case	Onset Date of Caretaker
38	6	1		16.7	09/10/98	
39	11	4	yes	36.4	09/03/98	09/14/98
40	9	1		11.1	09/14/98	
41	9	3		33.3	09/14/98	
42	9	1		11.1	09/11/98	
43	9	1		11.1	09/14/98	
44	9	0		0.0		
45*	9	7	yes	77.8	09/15/98	09/15/98
46	7	3	yes	42.9	09/09/98	09/12/98
47	1	0		0.0		
48	8	5	yes	62.5	09/07/98	09/08/98
49	7	1		14.3	09/10/98	
50	1	0		0.0		
51	8	2		25.0	09/10/98	
52	6	2		33.3	09/13/98	
53	10	0		0.0		
54	9	1	yes	11.1	08/20/98	08/20/98
55	8	1		12.5	09/13/98	
56	7	2	yes	28.6	09/15/98	09/18/98
57	6	4	yes	66.7	09/13/98	09/15/98
58	8	4		50.0	09/11/98	
59	7	3		42.9	09/11/98	
60	7	2		28.6	09/14/98	
Total	171	48		28.1		

*Inmates cared by No. 45 caretaker though became ill on 15 September, the two carriers were treated for diarrhea at the health center on 31 August, they were listed as confirmed cases.

Table 3. Water Consumption by Month

Month	Dec 97	Feb 98	Apr 98	Jun 98	Aug 98	Oct 98
Consumption (degree)	1176	1218	882	1150	1183	1307

Figure 1. Plan of the Institution and Distribution of Cases

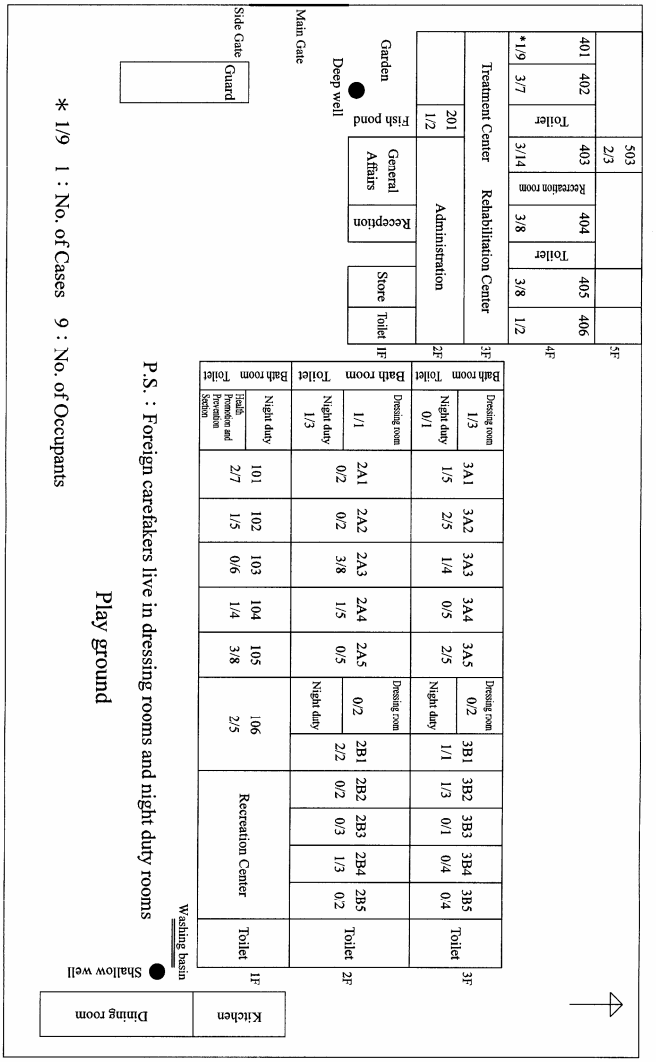

Figure 2. Distribution of Dates of Onset