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# Investigation of An Outbreak of Hepatitis A in Su-Chi Village, Ilan County

## 1. Introduction

Hepatitis A is transmitted mainly by the fecal-oral route, and occurs primarily in children. The epidemic is highly associated with age, social-economic status and local sanitary conditions[1,2]. Taiwan is a hyperedemic area for hepatitis A. The prevalence rate of hepatitis A among school children of junior high school and under in Taipei area had been higher than 90% before 1981. In 1991, the prevalence rate dropped to around 30%, although that of children aged 16 years and below in the mountain areas was still as high as 80-90%[3,4].

A notice was received at around 4 pm of 11 January 1994 that 8 students, 4 each of primary school and kindergarten, had been admitted to the Lotung Saint Mary's Hospital for suspected acute hepatitis A infection between 7 December 1993 and 11 January 1994. All are from Su-Chi Village of Tatung Township, Ilan County. An epidemiological investigation was conducted on 13 January to understand the mode of transmission and the related risk factors and also to prevent the further spread of the outbreak.

## 2. The Background

Su-Chi village is an aboriginal village of about 54 km to the south-west of Ilan City (Figure 1). Around 1,000 people live in a land area of 109.07 square meters. With the Su-Chi Primary School in the middle, the village is divided into upper and lower hamlets of 433 and 522 villagers respectively. They are the Tayals and of the Catholic religion. House are either concrete or wood. High mountain vegetable farming is the primary occupation. Chicken manure is used as fertilizer, flies are found everywhere in summer time.

There are in the village one primary school, one public kindergarten and one church. The church is where people gather and children play. Though there is a simple water supply system (the San-Sing Water Plant), spring water is more frequently used.

The spring water is brought to houses in plastic pipes, most of them are worn-out and patched with plastic tapes. Water tanks are dirty with moss. Most toilets in the villages are of the flush type without septic tanks. Some still use the pit-type toilets or no toilets at all. Human wastes are directly disposed into ditches.

Su-Chi Primary School is a two-story modern building in a good surrounding. The School has 116 teachers and students (including 12 of the Mau-An Branch). School lunch is supplied. All students have lunch at school even those who do not have class in the afternoon. The kitchen is newly built with two high temperature sterilizers. A woman cooks for the entire school. Water comes from the San-Sing Water Plant. The kindergarten is near the School admitting children of 4 to 6 years for day care. A teacher looks after them all. School lunch is also supplied.

The Lotung Saint Mary's Hospitals is a Catholic hospital offering special allowances to members of the church, villagers are often taken to this hospital. The health room attends to minor illness. There was an acute hepatitis A outbreak in the village in July to October 1985[5] with 16 cases. The median age of patients was 4 years and the attack rate, around 84%. Statistics of the Ilan County Health Bureau show that there was a Shigellosis outbreak in the village in August through October 1993 with most patients in the 16th neighborhood, and some in the 6th, 8th and 9th neighborhoods. The area of outbreak was similar to the present one.

## 3. Materials and Methods

To confirm the diagnosis and to decide whether it was an outbreak, visit was made to the Lotung Saint Mary's Hospital on 13 January to visit the five children still in hospital and to check their medical records. Five serum specimens were also collected for confirmation testings by the National Institute of Preventive Medicine, Department of Health. All medical records of acute hepatitis A patients admitted during last year in this hospital and a nearby hospital, the Po-Ai Hospital, were reviewed. In the period between February 1993 and 13 January 1994, there were 11 acute hepatitis A patients in the Saint Mary's Hospital. In addition to the 8 of the present incident, 3 had the infection in March 1993, and they are not residents of Tatung Township. Four patients had been admitted in the Po-Ai Hospital for acute hepatitis A, though only one was confirmed, and he is an adult of the plain area. Therefore, the current incident of Tatung Township was decided to be an outbreak.

Infected persons in the current incident are children aged 9 years and under. They are grouped as follows for the statistical analysis of serological testings and questionnaire interviewing:

Group 1: younger than one year old, the infant group,
Group 2: one to three years old, pre-kindergarten group,
Group 3: 4 to 6 years old, kindergarten group;
Group 4: 7 to 9 years old, primary school children group

1) Serological Testings

To understand the status of infection, all children aged 9 years and under in the village were blood-tested and injected with GAMMA 16 (Institut Merieux, 17 rue Bourgelat — 69002 Lyon — France, batch No. GO158), 1 cc for children weighed 10 kg and less, and 2 cc for those weighed more than 10 kg. Blood specimens were not collected from infants of six months and under nor were they injected with GAMMA 16 as blood-collection from infants was not easy and they would still have passive immunity from mothers anyway. Blood specimens were stored in portable freezer and sent to the National Institute of Preventive Medicine the next day for laboratory testings with the ELISA method for IgM anti-HAV and total anti-HAV antibodies.

2) Testing for Water Quality

Four each water specimens of tap water and spring water from the Primary School, the Kindergarten and homes of patients were collected by the Ilan County Health Bureau on 12 January 1994 and sent to the Ilan Environmental Protection Bureau for testings for total bacterial colony and *E. coli* tests.

3) Questionnaire Interview

A structural questionnaire was used to interview either the student or parent at the time of blood collection. The questionnaire was filled out with the assistance of either FETP members or teachers. The questionnaire includes: personal background information, symptoms, whether siblings being sick, source of drinking water at home, type of toilet, fertilizer used in farming, being to village gathering or banquet, eating and lliving with relative, and frequent playmate, etc.

For the study of risk factors, a case is defined as a child of 9 years of age and under (not including infant of less than 6 months) who had lived in Su-Chi Village during December 1993 and 14 January 1994 and was IgM anti-HAV positive. Children of both IgM anti-HAV and total anti-HAV negative were used as the reference group for analysis.

4) Statistic analysis

The dBASE III PLUS was used for data entry. The difference of age distribution between sample and total population was tested with Goodness of fit test. Chi-square test and multivariate stepwise multiple logistic regression of SPSS/PCT software package were applied to identify the related risk factors.

## 4. Findings

165 blood specimens were collected. The distribution of hepatitis A antibody positive

rates is shown in Table 1. There were 211 children aged 9 years and under (not including infants aged 6 months and under) in the village. The blood-collection rate was 78.2% (165/211). There were 7, 49, 58 and 51 children in the four groups respectively. Their age distribution was not significantly different from the population ($\chi^2$ = 5.454, df = 3, p = 0.136). The sample collected in the present study could represent the population of children aged 9 years and under.

1) Serological Testings

40 out of the 165 specimens were identified IgM anti-HAV positive, with a median age of 5 years. 15 of the 165 were found to have been infected previously (IgM anti-HAV negative and total anti-HAV positive). The attack rate thus was 26.6% (40/150). Attack rate by age group and total attack rate are shown in Table 1. However, after the blood collection on 14 January, two more children of originally IgM anti-HAV negative (OD values at 0.139 and 0.338, cut-off value at 0.403) were admitted to hospital and were both identified IgM anti-HAV positive (OD values at 1.080 and 1.200, cut-off value at 0.376).

2) Testing for Water Quality

Tap water samples of both the primary school and the kindergarten met the requirements. Two tap water samples of homes of patients met the requirements. Three of the four spring water samples collected from patients' homes were found to be in excess of total bacterial colonies and *E. coli*.

3) Analysis of Questionnaires

(1) Risk Factors

160 questionnaires had been collected from 165 samples. When all variables in the questionnaire were tested with $\chi^2$-test, variables such as the hamlet where they live, whether siblings being sick, drinking water and type of toilets, were found to be statistically significant (Table 2). When variables were controlled for multi-variate stepwise multiple regression analysis, of the three variables, children aged 7 to 9 years, hamlet of residence and whether siblings being sick, were selected into the regression model, and the last two variables were found to be significantly related to the present incident (Table 3).

(2) Epidemic Curve

Though 40 children were found infected in the serological testings, only the 8 who had been hospitalized had clear dates of onset, the rest who either did not develop symptoms or not treated did not have clear dates of onset. However, in the period between blood collection and 18 February 1994, 12 more children were taken to hospital.

The epidemic curve gives information of the 20 children. Figure 2 shows that both the date of onset and the number of patients clustered in January , only one case each week in the first three weeks of February, and no more case after the fourth week of February.

(3) Probable Source Case and Mode of Transmission

A four-year old boy (A1) was the first one to be admitted to hospital on 7 December 1993. From Figure 3, his six-year old female cousin (A2) became ill a week later, her four-year old brother (A3) became ill on 2 January 1994. Classmates of A2, A4, A5 and A10 became ill on 3, 4 and 20 January respectively. From Figure 3, contact with patient should be the likely route of transmission. After interviewing with the boy's parents, no identifiable source of infection was found.

(4) Distribution of Case by Family

The 40 IgM anti-HAV positive children come from 21 families, 17 of them are from the upper hamlet of the village. 51% (11/21) of families had two or more children infected.

## 5. Discussion

The village is aboriginal, their living conditions including water source, waste water disposal and water quality fail to meet sanitary requirements. Villagers are busy working in the field from dawn till dusk, the care of children in terms of personal hygiene and foods is often neglected. These environmental factors are the major potential factors for this hepatitis A outbreak. The prompt report of the local practicing physician made the authorities concerned to take immediate effective preventive measures to prevent the spread of the disease. Once again, practicing physicians should be made to realize that reporting of outbreak is essential to disease control and has great impact upon the health of the people.

In USA, around 40% of hepatitis A patients had no known risk factor for infection, contact with patients is found to be the most frequent risk factor[6]. Similar surveys in Taiwan also show that personal contact is the major mode of transmission[7]. Statistical analysis shows that the hamlet of residence and whether siblings being sick are risk factors of this incident. From the chart of infection among children, personal contact is obviously the major mode of transmission of this outbreak.

Around 80-90% of children infected with hepatitis A virus are often asymptomatic[8,9]. In the questionnaire interview of the 40 IgM anti-HAV positive children, 23 mentioned one of the symptoms such as jaundice, nausea, vomiting, diarrhea and fever. Thus the asymptomatic rate is 42.5% (17/40), and it seems to be overstated.

This incident was much simpler than the hepatitis A outbreak happened 8 years ago (1985) in this village[5]. The previous outbreak spread out gradually from one village

along the highway; the current outbreak stayed in the village only. This perhaps was due to the prompt effective preventive measures. The ratio of susceptible persons of this outbreak (65.5%) was higher than the previous one (56%), though the attack rate (26.6%) was much lower (84%). The median age of infected persons went up from 4 to 5 years. This may have been related to the improved living standard. This outbreak was more similar to the hepatitis A outbreak of last year in some aboriginal villages of Kaohsiung County[10]. However, age groups investigated in that outbreak were different from those of this one, they could not be compared directly. The time of intervention after outbreak is also an important factor affecting the disease attack rate. In the current outbreak, investigation took place earlier, the attack rate could have been underestimated, further follow-up survey would be required.

The investigation found that the anti-HAV antibody ratio of children aged one year and under was zero. This was different from the findings of the antibody prevalence surveys of 1,100 and 1,200 children aged 12 years and 15 years and less in Taipei City[11,12]. These studies indicated that 27% of infants were still with anti-HAV antibodies. The number of children aged one year and less in the present survey was only 7, this small sample size could have been the reason for the bias.

By Gust's epidemiological patterns of hepatitis A, the present outbreak is the Type 3, that is, outbreak occurs in a closed or semi-closed community, almost all susceptible individuals become infected after one outbreak, and subsequently born children become susceptible; when sufficient number of susceptibles is accumulated, should the virus be reintroduced and another outbreak occurs. The source of virus should be similar to the study of the Orchid Island residents[14], that is, hepatitis A virus is always in the community and with the accumulaton of susceptibles, outbreak occurs. Whether the outbreak of 8 years ago and the current outbreak make a cycle remains to be studied further.

Robertson took from WHO HAV strain bank 171 hepatitis A viruses for nuclear acid sequence[15] analysis and concluded that there were seven different genotypes of hepatitis A viruses in the world. Of them, four are pathogenic to human, the rest three were isolated only from simian species. That the contamination of the environment by the use of chicken manure as fertilizer should not be the cause of the present outbreak, though the general sanitary conditions of the village ought to be improved.

Though children of primary school and below were injected with GAMMA 16 on 14 January, up until 18 February, 12 more children had been admitted to hospital for acute hepatitis A infection. They were identified IgM anti-HAV positive, though nine of them had been injected with GAMMA 16. The injection after 2 weeks exposure to the hepatitis A virus was probably no longer effective.

Of the subsequent cases, two were originally IgM anti-HAV negative and total anti-HAV positive. They could have been infected with hepatitis A previously and should had developed immunity against the virus. The two were admitted to hospitals when symptoms developed, and were identified IgM anti-HAV positive. Possible reasons are:

1) Around 15-20% of persons with hepatitis A infection history could relapse[16], though more common among adults[17]. However, whether hepatitis A infection can relapse is still debated.

2) They could have just been infected when their blood was collected on the day. The test reagents were not sensitive enough to detect the small amount of IgM anti-HAV antibody.

It was at one time thought that the infection was due to virus of different genetic type, for the nuclear acid sequence of the four human strains of HAV have a 15-25% difference. Studies show, however, that the antigenicity of most strains of hepatitis A virus is similar[18], chance of different strains of virus including different immunological reactions are small.

## 6. Recommendations

1) Water supply of the village should be improved. Tap water should be used.

2) Waste water disposal should be improved. Human waste and household waste should not be disposd directly into ditches.

3) Health education should be strengthened. People should be taught to wash hands before meal and after toilet and not to drink from tap or spring water without boil.

4) The use of chemical fertilizer should be encouraged to avoid spreading diseases.

5) When safe and effecive vaccine against hepatitis A becomes available, it should be used for these high-risk groups.

## 7. Acknowledgement

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**Table 1. Findings of Serological Testings**

| Age | No. examined | Anti-HAV (+) IgM (−), (%) | No. susceptible* | IgM (+) | Attack rate** (%) |
|---|---|---|---|---|---|
| 1 | 7 | 0 (0.0) | 7 | 0 | (0.0) |
| 1 | 13 | 0 (0.0) | 13 | 1 | (7.7) |
| 2 | 24 | 1 (4.2) | 23 | 8 | (34.8) |
| 3 | 12 | 1 (8.3) | 11 | 1 | (9.1) |
| 4 | 18 | 1 (5.6) | 17 | 7 | (41.2) |
| 5 | 19 | 1 (5.3) | 18 | 5 | (27.8) |
| 6 | 21 | 0 (0.0) | 21 | 5 | (23.8) |
| 7 | 17 | 0 (0.0) | 17 | 5 | (29.4) |
| 8 | 17 | 1 (5.0) | 17 | 4 | (25.0) |
| 9 | 17 | 10 (58.8) | 7 | 4 | (57.1) |
| Total | 165 | 15 (9.1) | 150 | 40 | (26.6) |

* Susceptibles = No. examined − No. IgM (−), anti-HAV (+)
**Attack rate = No. IgM (+) / No. susceptibles

**Table 2. Testing of Risk Factors by $\chi^2$-Test**

| Variable | Patient group | Non-patient group | Statistical analysis |
|---|---|---|---|
| Sex | | | |
| Male | 21 | 53 | $\chi^2 = 0.22$ |
| Female | 19 | 57 | df = 1, p = 0.64 |
| Age | | | |
| < 1 | 0 | 7 | |
| 1-3 | 10 | 37 | $\chi^2 = 4.33$ |
| 4-6 | 17 | 39 | df = 3, p = 0.23 |
| 7-9 | 13 | 27 | |
| Schooling | | | |
| Not in school | 12 | 46 | $\chi^2 = 1.56$ |
| In kindergarten | 11 | 28 | df = 2, p = 0.46 |
| Primary school | 14 | 31 | |
| Residence | | | |
| Upper hamlet | 33 | 68 | $\chi^2 = 6.24$ |
| Lower hamlet | 7 | 36 | df = 2, p = 0.04* |

**Table 2. Testing of Risk Factors by $\chi^2$-Test (Continued)**

| Variable | Patient group | Non-patient group | Statistical analysis |
|---|---|---|---|
| Occupation of Parent | | | |
| Military, government | 3 | 5 | $\chi^2 = 7.79$ |
| Agriclture | 37 | 85 | df = 3, p = 0.05 |
| Labor, commerce | 0 | 9 | |
| None | 0 | 9 | |
| Education of Parent | | | |
| Junior high and less | 34 | 96 | $\chi^2 = 0.08$ |
| Senior high and above | 5 | 12 | df = 1, p = 0.07 |
| Source of Water | | | |
| Tap water | 6 | 26 | $\chi^2 = 4.41$ |
| Spring water | 27 | 71 | df = 3, p = 0.22 |
| Both | 6 | 11 | |
| Drinking of Water | | | |
| Drink raw water | 5 | 2 | $\chi^2 = 7.85$ |
| Drink boiled water | 32 | 92 | df = 2, p = 0.02* |
| Both | 3 | 14 | |
| Water for Washing | | | |
| Tap water | 6 | 23 | $\chi^2 = 0.79$ |
| Spring water | 32 | 79 | df = 2, p = 0.67 |
| Both | 2 | 6 | |
| Type of Toilet | | | |
| Flushing | 19 | 74 | $\chi^2 = 7.57$ |
| Pit privy | 19 | 26 | df = 2, p = 0.02* |
| Septic tank | 2 | 8 | |
| Siblings Sick | | | |
| Yes | 16 | 24 | $\chi^2 = 27.36$ |
| No | 6 | 102 | df = 1, p = 0.00** |
| Fertilizer Used | | | |
| Chemical | 13 | 27 | $\chi^2 = 1.90$ |
| Manure | 24 | 70 | df = 3, p = 0.59 |
| Eat in Restaurant | | | |
| Yes | 5 | 35 | $\chi^2 = 0.24$ |
| No | 17 | 91 | df = 1, p = 0.62 |
| Being to Banquet | | | |
| Yes | 11 | 38 | $\chi^2 = 0.78$ |
| No | 29 | 70 | df = 1, p = 0 38 |
| Being with Relative | | | |
| Yes | 7 | 14 | $\chi^2 = 0$ 49 |
| No | 33 | 94 | df = 1, p = 0 48 |

* p < 0 05, ** p < 0 005

**Table 3. Stepwise Multiple Logistic Rregression Analysis of Risk Factors**

| Variable | B | Exp (B) | P-value |
|---|---|---|---|
| Live in lower hamlet | −1.4499 | .2346 | .0137 |
| Siblings sick or not | 2.6894 | 14.7231 | .0000 |
| Constant | −1.1518 | | .0000 |

Chi-square = 31.362, df = 2, p = 0.00

**Figure 1. Location of Su-Chi Village**

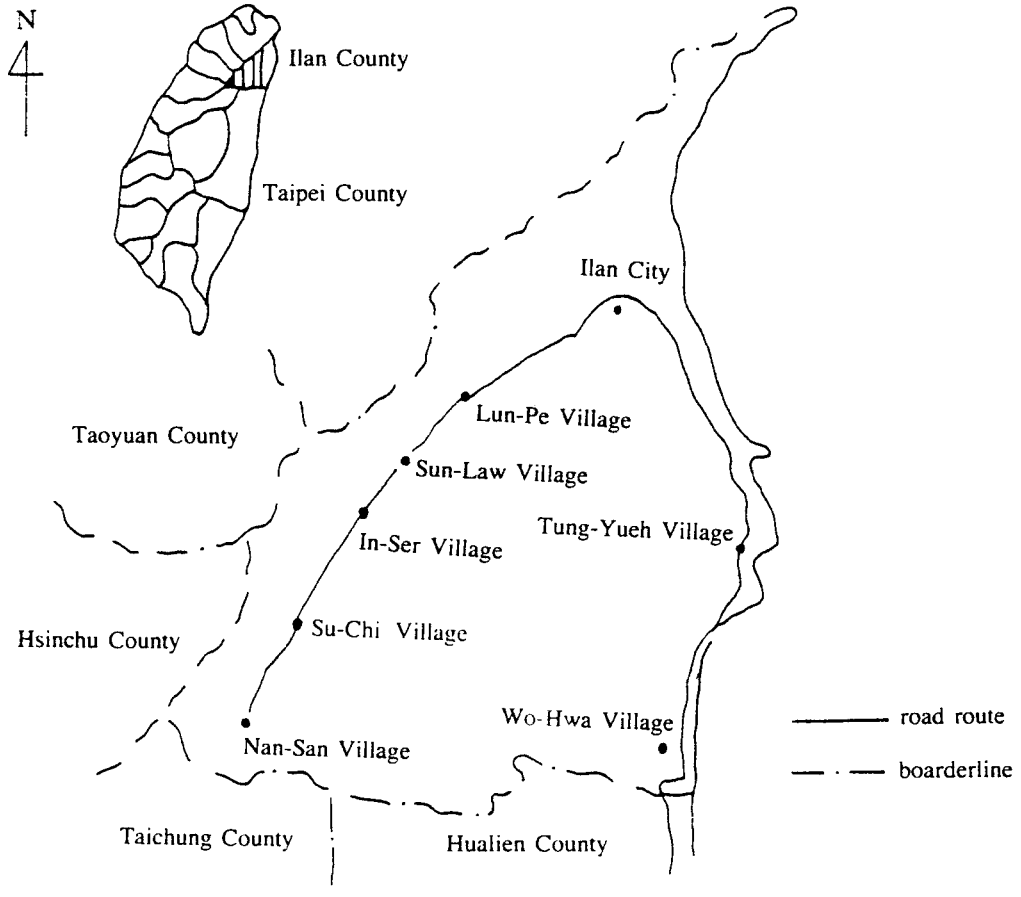


**Figure 2. Epidemic Curve (82, 12 ~ 83, 2)**

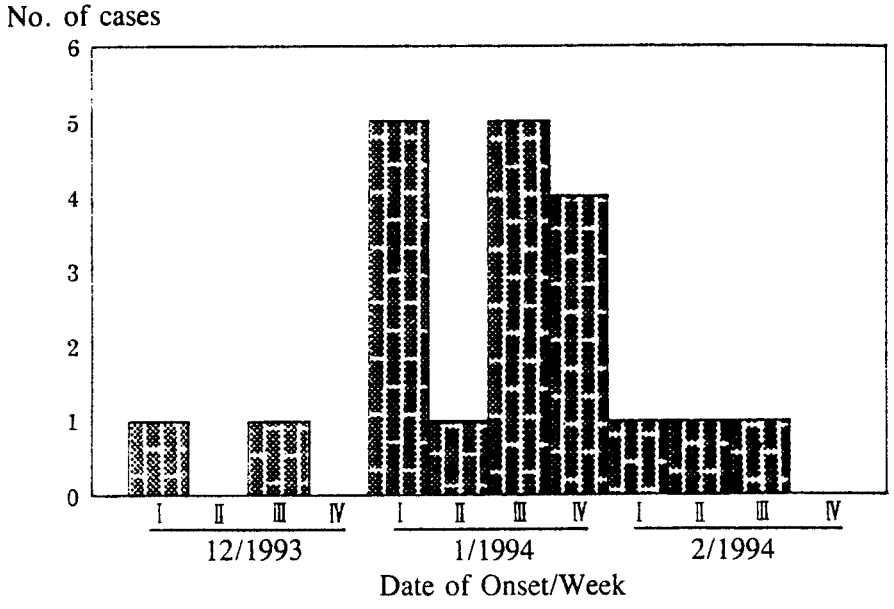
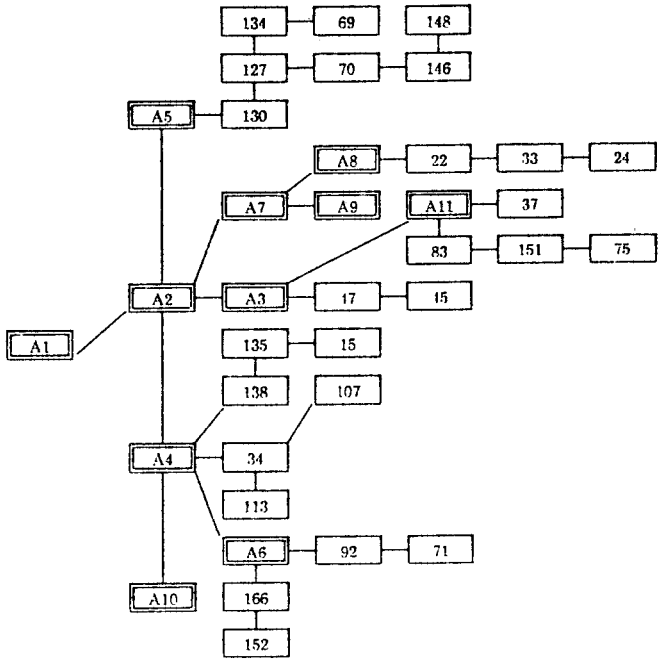



**Figure 3. Infection Among Children**




— siblings / cousins | classmate, playmate
= known date of onset as follows

| Case | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dae of onset | 7/19/93 | 15/12/93 | 1/2/94 | 1/3/94 | 1/4/94 | 1/6/94 | 1/7/94 | 1/9/94 | 1/17/94 | 1/20/94 | 1/21/94 |