ISSN 1021-366X

An Investigation of a Scarlet Fever Outbreak at a Nursery in Taichung City

Abstract

The purpose of this investigation was to determine the scale of the infection, route of transmission, and the relevant risk factors of a scarlet fever outbreak which occurred in early March, 2000, at a nursery in Taichung City. A structured questionnaire was used to interview 199 children (interview rate 87.6%). The questionnaire contained questions concerning personal background, date of disease onset, clinical symptoms, medical treatment, means of transportation to school, recent travel and similar symptoms in family members or friends. The 23 cases with suspected symptoms and contacts underwent laboratory testing for group A β-hemolytic streptococci.

Of the children interviewed, five (two males and three females) were confirmed and three (all females) were suspected cases, yielding a total attack rate of 4% (8/199). Their symptoms were, in order of frequency: desquamation of skin of hands and feet 62.5% (5/8), rough skin and sore throat (37.5% each, 3/8), rash, strawberry tongue, fever (25.0% each, 2/8), and fatigue (12.5%, 1/8). Most infections occurred between March 6 and 16, while the index case

appeared on 6 March. Of the 23 suspected cases and contacts, five were found to be group A β-hemolytic streptococcus positive.

The environment of the nursery was relatively clean. Ventilation was good. Air-conditioning was not used. Statistical analysis did not show any association between either the means of transportation to school or recent travel and the infection (p value of each >0.05). Epidemiologically, many cases were related in terms of time and space, their dates of onset were within the incubation period of scarlet fever, therefore close personal contact was likely the major route of transmission.

Introduction

Scarlet fever, an infection prevalent before the 19th century, was a fatal disease of children[1,2]. In the Taiwan area in the ten years between 1931 and 1941 there were on average more than 50 cases of scarlet fever each year, and the average mortality was between 2.0% and 5.0%[3]. In 1934 and 1935, outbreaks infecting 418 and 227 persons occurred in the Taiwan area. Thereafter, the number of reported cases per year remained at greater than 10, though reaching 219 cases in 1994, 105 in 1995, and about two hundred in 1996[4]. Due to changes in environment and improvement in medical science, large-scale outbreaks of scarlet fever are now rare, although small-scale outbreaks are fairly frequent. For instance, the outbreaks in February-March 1996 at a day care in a medical center, and in December 1997 at a nursery in Taichung City are two incidences in point[5,6]. A similar outbreak occurred in a nursery in Taichung City. On 9 March 2000, the Taichung City Health Bureau was notified of some suspected scarlet fever cases at a nursery. Subsequent laboratory testing of the suspects and contacts identified several

positive reactions for group A β-hemolytic streptococcus. To ascertain the scale of the infection, route of transmission, and likely risk factors of the outbreak, the FETP, Division of Epidemiology, of the Center for Disease Control, DOH, immediately dispatched a team to carry out an epidemiological investigation.

Methods and Materials

Subjects for Investigation

The nursery in question is located in the west district of Taichung City. The nursery had an enrollment of 227 children divided into ten classes by age, five classes for children of older ages (named the Rabbit, Elephant, Panther, Hippo, and Butterfly), three for children of younger ages (Penguin, Whale, and Squirrel), and two for the youngest children (Swan and Sheep). As no adults were infected, the investigation focused on children of the nursery only, teachers and staff members were excluded.

Survey of the Environment

The environment, facilities, ventilation and use of air-conditioning of the nursery were surveyed. The classes and locations of the cases were mapped. Their activities and contacts were surveyed. Questions regarding changes in symptoms before and after infection were asked. Their state of health after recovery was noted. Teachers were interviewed and school records checked to assess the state of health of the cases before and after infection and their contacts. The likely index case was identified and his/her contacts with other children studied to determine the route of transmission for prevention and control.

Questionnaire Interview

A structured questionnaire was used. The questionnaire contained questions on personal background, date of onset, clinical symptoms, medical treatment, means of transportation to school, recent travel, and similar symptoms in family members or friends. Copies of the questionnaire were distributed to children on 17 March to be filled out by parents at home and returned by 23 March.

Specimens Collection and Laboratory Testing

The local health station began to collect specimens from suspects and contacts soon after the infection was reported on 9 March. On March 13, 14 and 15, all children of the nursery were screened for symptoms, and specimens; 23 pharyngeal swabs in total, were collected from suspected cases for laboratory testing by the Third Branch Office of the Center for Disease Control.

Cotton swabs were used to swab tonsils and the posterior pharynx. Specimens were then placed in Clary-Blair transport medium and sent to the laboratory. One to five colonies were selected and placed on sheep-blood plate for culture for 18-24 hours. If the microorganisms were microscopically gram-positive, in either single or paired chain-formation of various lengths, with β-hemolytic reaction around the colonies, they were considered to be most probably group A β-hemolytic streptococci. They were then confirmed to be group A β-hemolytic streptococci by catalyzer test and direct antigen test[7].

Definition of Cases

Confirmed case: one who clinically developed one of the following symptoms

between March 1 to 16: typical rash, desquamation of the skin of hands and feet, strawberry tongue (could be preceded by acute fever, sore throat, or tonsillitis), and by laboratory testing showed positive reaction for β-hemolytic group A streptococcus[8].

Suspected case: one who between March 1 to 16 clinically developed one of the following symptoms: typical rash, desquamation of skin of hands and feet, or strawberry tongue (could be preceded by acute fever, sore throat, or tonsillitis), though by laboratory testing, no β-hemolytic group A streptococci were isolated.

Carrier: one who though did not demonstrate any symptoms of scarlet fever between March 1-16, but whose laboratory test findings were positive for group A β-hemolytic streptococci.

Normal person: one who did not demonstrate any symptoms of scarlet fever between March 1 and 16 and did not require laboratory testing.

Study Methods

Retrospective cohort follow-up study method was used. In the statistical analysis process, both confirmed cases and suspected cases were combined as “cases”; and both the normal persons and carriers were grouped together as “non-cases”.

Data Processing and Analysis

Data were keyed into the computer with Epi-Info 6.04 sofware for description in terms of frequency and percentage and statistical analysis by Fisher exact test. Excel of Microsoft was used for figures showing the distribution of cases and dates of onset.

Results

The nursery, a two-story building, is located on Minchuan Road of Taichung City in a land area of about 1,600 m^2 with an unrestricted view. There was no evidence of air pollution. Ventilation and lighting in the classrooms are good. Not many buildings are located around the nursery. The time in question, March, was early springtime, so no air-conditioning was needed. In terms of the environment and facilities of the nursery, no factors were detected that might have had any association with the outbreak.

A total of 227 copies of the questionnaire were distributed, and 199 were returned, with a return rate of 87.6%. More copies of the questionnaire were returned by children of older ages; the youngest children returned few copies. The number of copies returned by class is shown in Table 1. Of the 199 copies returned, 108 (54.3%) were by boys, and 91 (45.7%) by girls. The age range fell between 3 to 7, with a median of 6 years. 99 children of the total were aged 6 (49.8%); 64 aged 5 (32.1%); 28 aged 4 (14.1%); 5 aged 3 (2.5%); and 3 aged 7 (1.5%).

Eight cases were identified through questionnaire interview and laboratory testing. Of the eight, five were confirmed (2 males and 3 females), and three were suspected cases (all females), yielding a total attack rate of 4.0% (8/199). The remaining 191 children (96.0%, 191/199 of those interviewed) were normal. Distribution of cases by class is shown in Figure 1. It can be noted from Figure 1 and Table 1 that, the class Penguin had the highest (12.0%, 3/20) attack rate; Hippo the second, at 8.7% (2/23); Swan at 6.3% (1/16); Squirrel at 4.8% (1/21), and Butterfly at 4.0% (1/25). Symptoms of these eight children

were, desquamation of the skin of hands and feet (62.5% 95/8), rash, rough skin, and sore throat (37.5% each, 3/8), strawberry tongue and fever (25.0% each, 2/8), and fatigue (12.5%, 1/8). Six of them developed (see Figure 2 for time of onset) symptoms between March 13 to 16; and one each on March 6 and 9. They were medically treated but not hospitalized. Four of them had recovered before the investigation; two of them (one suspect) continued their medical treatment, and two suspects had been given prophylactic medicine.

Of all children, 146 (73.4%) were escorted by parents to school; 52 (26.1%) went to school by school bus; and only one (0.5%) went to school alone. Of those who went to school by school bus, one (1.9%) was infected. Of those who were escorted to school by parents, seven (4.8%) were infected. Means of going to school did not seem to be associated with the infection ($p>0.05$, Table 2). Recent travel was also not associated with the infection (p.0.05, Table 2).

Discussion and Conclusion

Scarlet fever is contagious, and is, in Taiwan, a notifiable disease. It is a common disease of the upper respiratory tract of children, and is believed to be induced by group A β-hemolytic streptococci. The microorganisms can often be isolated from secretions of the skin, mucous membranes, throat, and respiratory tract[1,5,7,9,10]. It is transmitted primarily through contact or droplets, often in families and schools. It occurs more frequently from December through February. Its symptoms are different from those of other group A streptococcal infections. Rashes are seen more often on the neck, chest, axilla, elbows, groin and inner thighs but not on the face. Desquamation of the skin of hands and feet , sore throat and strawberry tongue

may accompany other symptoms. The symptoms of the cases of the nursery in question were typical of scarlet fever.

From March 6 through 16, 2000, there were eight cases of scarlet fever at a nursery in Taichung City. This was considered more serious than the outbreak in the same city, which occurred from January 1 through 29 February 2000 involving four cases. The total attack rate of the present incident was 4.0%, and was close to the 3.0% reported elsewhere[11]. No deaths occurred. Both the incidence and mortality of scarlet fever in Taiwan have significantly declined[12]. Outbreaks and even deaths from scarlet fever are still reported from the US, UK, Japan, Spain, Germany and Russia[13-19]. Poland for the last ten or more years has had outbreaks of scarlet fever infection each year. Every year they issue a special publication on scarlet fever to discuss its epidemiology in Poland[20]. Scarlet fever is a threat to life in both developed and developing countries; the importance of this ancient disease should not be overlooked.

The disease is transmitted by droplets of the respiratory tract from either patients or carriers, particularly persons carrying pathogenic strains in their nasal cavities, through direct contact. It is rarely transmitted indirectly through objects[1]. The present incident, as revealed by the investigation, did not appear to have any association with the environment of the nursery. The nursery was clean, ventilation was satisfactory, and air-conditioning was not used. The environment was similar to that reported by Lu, et al.[6], the possibility of airborne transmission was excluded. In terms of means of going to school, most children (73.4%) were escorted to school by parents, and seven of them were infected. Of those who went to school by school bus, one was infected. Statistical analysis, however, showed that the outbreak was not

associated with the means of going to school ($p>0.05$). This finding was similar to that of Lu, et al.[6]. None of the cases had been abroad or traveled elsewhere; travel was also not found to be associated with the outbreak ($p>0.05$). It is possible that the present outbreak did not originate from a common source of infection, but was rather a transmission through contact and droplets.

From the distribution of cases and dates of onset (Figure 2), the route of transmission may have occurred as follows: the index case was a girl in the class Penguin. She developed symptoms on March 6 and was also confirmed positive for group A β-hemolytic streptococcus. One of her classmates developed symptoms on March 9, and later her elder brother (in class Butterfly) on March 13. Another classmate of class Penguin developed symptoms of scarlet fever on March 16. One of the twin sisters in class Hippo developed symptoms on March 13, and the other one, on March 14. The classrooms of these six cases were on the second floor. The classrooms of the other two cases were on the first floor, one in class Squirrel (developed symptoms on March 14), and the other one in class Swan (developed symptoms on March 13). It is possible that they had play contact with cases on the second floor, though they did not quite remember details of their contacts. Due to the close association of cases in terms of time and space, and the dates of onset all being within the incubation period of scarlet fever, it was most likely that close contact was the primary route of transmission.

The eight cases had either recovered or had been placed on medication. No more cases other than those reported had been referred by either school teachers or parents for medical care. It may have been that the symptoms of some children were mild and unnoticed, and unless confirmed by laboratory

testing positive for group A β-hemolytic streptococcus, they would have been treated as a common cold. Scarlet fever is diagnosed by clinical symptoms and confirmed through laboratory testing of pathogenic agents. Bacteriologically, group A streptococci is classified into 1-29 types. By M-protein, they can be serologically grouped into 80 types, with further immunological subtypes. Different types, either sero-types or immuno-types, may have different clinical manifestations; their control measures and prognoses are also different[1,13,14]. Ohga et al.[13] reported that the two scarlet fever outbreaks in Japan in 1989-1990 and 1991 were induced by pathogenic agents of three different types, T4, T12, and T22. The second outbreak, however, was primarily induced by T4, with significant symptoms of strawberry tongue and rash, and less suppurative tonsillitis. The infection was more resistant to the antibiotic Amoxicillin[13]. It was therefore, suggested that the serological diagnosis of scarlet fever should also include testing for T4. Shiseki et al.[13] found that mice produced a lower level of anti-phagocytic activity and streptolysin O (SLO) to group A streptococcus (GAS) and lower fatality, and therefore concluded that GAS had different pathogenic factors.

Whether different clusters of a relatively large-scale outbreak of scarlet fever are induced by the same pathogenic agent can be assessed by the RAPD (random amplified polymorphis DNA) method. RAPD is a useful tool in epidemiology. Hsueh et al.[5] used this method to evaluate the GAS of confirmed cases, suspected cases and carriers in the 1996 scarlet fever outbreak in Taiwan. They found that 96.0% of cases were of streptococcal pyrogenetic exotoxin type B, and that although they were different in their clinical manifestations, they were induced by pathogenic agents of the same type. No further bacteriological typing was made in the present investigation as cases of the present incident were not seriously ill and were not hospitalized. To

quickly and accurately diagnose infection, predict effects of treatment, and to more effectively prevent and control disease, advanced simple, rapid and accurate testing methods should be developed.

Some researchers[2,17,21-24] have studied associations between scarlet fever and lifestyle or environment to identify factors related to the infection, in order to gain more effective control of the disease. A study by Duncan[2] was most impressive. He studied changes in the mortality of scarlet fever in the United Kingdom in the period 1840-1880 and after 1880. He found that the mortality of scarlet fever in children peaked in 1840-1880, and declined sharply after 1880. He drew a graph with two lines for comparison, one for the trend of mortality, and one for the trend of the price of wheat. The two lines ran parallel, with a time lapse of about three years. When the price of wheat was high, the number of malnourished pregnant women increased, and children born later were more prone to scarlet fever infection. Weather in the United Kingdom in spring and summer is dry and undergoes sporadic changes. In 1847-1880, the death rates for scarlet fever increased and declined in about a 5-6 year cycle. He therefore concluded that the mortality of scarlet fever in children was associated with the price of wheat. The average national income in Taiwan is relatively high, and malnutrition of pregnant women due to changes in the price of rice is unlikely to occur under normal circumstances. Children of the nursery in question were healthy and no malnutrition was noted. However due to recent disasters in Taiwan such as earthquakes and floods, changes in the living environment, as well as quality and quantity of food intake of pregnant women during times of disaster may have occurred. The suggestion of Duncan that there is a time lapse between outbreaks and changes in environment should be given some consideration.

Prepared by: Chiang TH[1], Lien HL[1,2], Tu CT[3], Lai HK[3], Chen HC[4]

1. FETP, Center for Disease Control, DOH
2. Department of Radiology and Tumor, College of Medicine, Kaohsiung Medical University
3. The Third Branch Office, Center for Disease Control, DOH
4. Taichung City Health Bureau

For further information, please contact Mr Lien HL

References

1. Benenson AS. Control of Communicable Diseases Manual, 16th ed., American Public Health Association, Washington, DC, 1995; 438-445.
2. Duncan CJ, Duncan SR, Scott S. The dynamics of scarlet fever epidemics in England and Wales in the 19th century. Epidemiol Infect 1996; 117(3): 493-499.
3. Department of Health. Health and Vital Statistics, 1997.
4. Department of Health. Control of Communicable Diseases Manual. November 1996.
5. Hsueh PR, Teng LJ, Lee PI, et al. Outbreak of scarlet fever at a hospital day care center: analysis of strain relatedness with phenotypic and genotypic characteristics. J Hosp Infect 1997; 36(3): 191-200.
6. Lu HC, Chao TY, Chiu CS, et al. An epidemiological investigation of a scarlet fever outbreak at a kindergarten in Taichung City. Epidemio Bulletin, 1998; vol 14 No 7, 227-236.
7. National Institute of Preventive Medicine, DOH. Manual of Standard Operational Procedures for Laboratory Testing for Disease Control. March 1995.
8. Center for Disease Control, DOH. Definitions for the Reporting of Notifiable Diseases.
9. Huang TC. Scarlet fever. J of Noscom Infect Control, 1996; 6(5): 262-265.
10. Gray BM. Streptococcus Infection, Bacterial Infections of Human, 3rd ed.,

Plenum Medical, New York, 1992; 639-667.

11. Bisno AL. Rheumatogenic group A streptococci. Acta Cardiol Sin, 1985; 1: 36-39

12. National Quarantine Service, DOH. Annual Report of Communicable Diseases, 1995. October 1995.

13. Ohga S, Okada K, Aoki T, et al. Outbreaks of group A beta-hemolytic streptococcal pharyngitis in children: correlation of serotype T4 with scarlet fever. Scand J Infect Dis 1992; 24(5): 599-605.

14. Shiseki M, Miwa K, Nemoto Y, et al. Comparison of pathogenic factors expressed by group A streptococci isolated from patients with streptococcal toxic shock syndrome and scarlet fever. Microb Pathog 1999; 27(4): 243-252.

15. Casani Martinez C, Morales Suarez-Varela M, Santos Durantez M, et al. Recurrent scarlet fever. An Esp Pediatr 1999; 51(3): 300-302.

16. Martinez Gutierrez A, Machin Valtuena M, Nebreda Mayoral T, et al. An outbreak of scarlet fever in an urban health center in 1997. An Esp Pediatr 1998; 48(1): 103-104.

17. Briko NL, Gureeva EG, Kuznetsov AN, et al. The manifestation of a scarletina epidemic process in large city and their interpretation. Zh Mikrobio Epidemio Immunogiol 1994; 2: 57-62.

18. Grigorescu R, Ivan A, Azoicai D, et at. The epidemiological characteristics of an infection with beta-hemolytic streptococcus group A in Iasi county a decade of observation. Bactriol Virusol Parazitol Epidemiol 1993; 38: 52-56.

19. Schmitt HJ. Scarlet Fever. Dtsch Med Wochonscha 1993; 23(118): 1094.

20. Czarkowski MP. Scarlet fever in 1997. Przegl Epidemiol 1999; 53: 33-40.

21. Shiratori T, Morita M, Mogi T, et al. Epidemiological study on scarlet fever. Kansenshogaku Zasshi, 1973; 47(12): 510-513.

22. Eyler JM. The epidemiology of milk-borne scarlet fever: the case of

Edwardian Brighton. Am J Pub H, 1986; 76(5): 573-584.

23. Canals M. Epidemiologic dynamics of scarlet fever in Chile. Rev Chil Pediatr, 1989; 60(1): 15-18.

24. Krasil'nikov IA, Iontova IM, Sobolevskaia AA, et al. The general characteristics of the epidemic process and of the circulating streptococcal strains during an upsurge in scarlatina morbidity in Leningrad. Zh Mikrobiol Epidemiol Immunobiol 1990; 1: 33-37.

Table 1 No. of Children in the Nursery in Taichung City

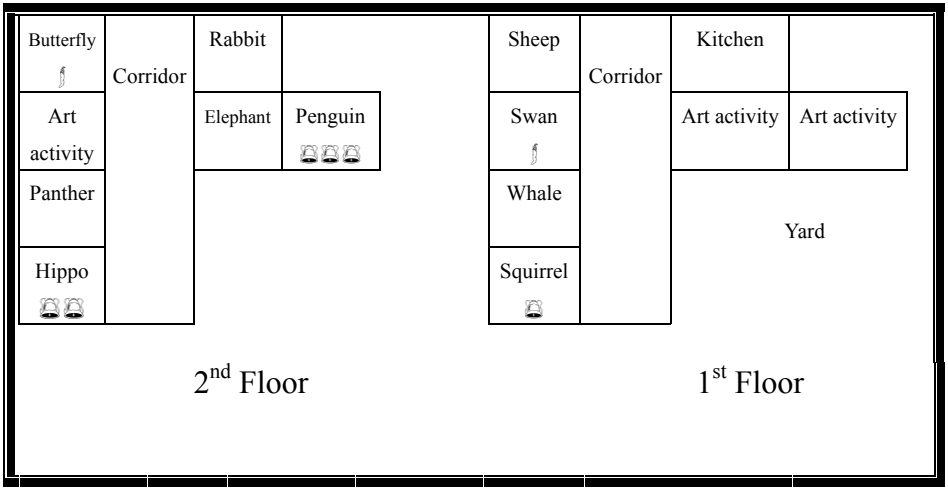
Item	Class										Total
	Rabbits	Elephant	Panther	Hippo	Butterfly	Penguin	Whale	Squirrel	Swan	Sheep	
No.of Children	22	25	22	25	25	25	22	21	21	19	227
No. of questionnaire returned	20	19	19	23	25	20	20	21	16	16	199
No. of cases	0	0	0	2	1	3	0	1	1	0	8
Attack rate%	0.0	0.0	0.0	8.7	4.0	12.0	0.0	4.8	6.3	0.0	4.0

Table 2 Risk Factors of the Scarlet Fever Outbreak

Item	No. of Cases	No. of Non-Cases
Ways to school		
By school bus	1	52
Escorted by parents	7	138
Went to school alone	0	1
Recent traveling		
Yes	0	39
No	8	152

* Fisher's exact test，p>0.05。

Figure 1 Distribution of Cases



♂：male case；♀：female case