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Hand Washing as a Preventive Factor for a Chickenpox Outbreak in a Rural School, Yunnan Province, China

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Abstract

In China, usage of varicella vaccine is limited due to cost even though varicella outbreaks are common among children. On 8 Dec 2006, a varicella outbreak occurred among school children in a remote area of Yunnan Province. In this area, median annual income was less than 200 USD. We conducted an investigation to define risk factors and determine affordable control measures. A retrospective cohort study was conducted. Cases were identified through school health records and active case finding. Data on demographics, symptoms, behavior, vaccination status and previous varicella infection were obtained by questionnaire. Chickenpox cases were defined as students with generalized, vesicular pruritic rash lasting 3 or more days from 1 Sep to 14 Dec 2006. Of 604 students, 564 (93%) participated in this study. None had received chickenpox vaccination. 145 (26%) had history of past infection. Attack rates were 56% (236/419) among students without prior infection. Attack rates were higher in younger age groups (80% in 5-7 years, 75% in 8-10 years) than in the older age groups (32% in 11-13 years, 19% in 14-17 years). In multivariate analysis, close contacts with cases (Adjusted OR 2.5, 95% CI 1.6-4.0) and touching chickenpox lesions (Adjusted OR 17.8, 95% CI 4.0-78.3) were risk factors. Hand washing (Adjusted OR 0.4, 95% CI 0.2-0.7) was protective. Hand washing was promoted as an affordable control measure in this setting. Health education was implemented, emphasizing avoidance of contact with cases, especially touching lesions.

Keywords: chickenpox, varicella, hand washing, China

Introduction

Chickenpox, which is also called varicella, is an acute viral infectious disease. It is caused by Varicella Zoster Virus (VZV). The disease is characterized by itchiness and skin rash with fluid-filled blisters that burst and form crusts. Onset of chickenpox rash may be preceded by fever and general malaise. The rash begins with a few small reddish bumps (papules) that are quickly filled with fluid to form small blisters (vesicles). The vesicles appear in "crops", small groupings, first on the trunk and then spread to the extremities, face and scalp over a period of two to four days.[1] It is relatively easy to diagnose as the smallpox was already eradicated.

The average incubation period is 14 days, with a range from 10 to 21 days. It is infectious 48 hours prior to onset of vesicular rash until all vesicles are crusted and the vesicles generally last four to five days. There is universal susceptibility in those whom are not vaccinated or previously infected. Furthermore, it is highly contagious and Secondary Attack Rate (SAR) can be 85%.[1] Close contact, crowding condition, lack of hand washing facility can increase the spread. Isolation of chickenpox cases has a limited role in outbreak prevention.[2,3] Once after infected, lifelong immunity against recurrent infection is usually present.[1]

Varicella infection is not a notifiable disease in China and the varicella vaccine is not included in the current Expanded Program on Immunization (EPI) due to high cost and unknown length of infection.[3] According to the Department of Price from National Development and Reform Commission in China, the price of varicella vaccine was about 23 USD in 2006. Thus, usage of varicella vaccine is limited in China, especially in underdeveloped areas. Varicella outbreaks are common among Chinese children. 864 outbreaks were reported in China during 2006 and 98% of them occurred in schools. On 8 Dec 2006, a varicella outbreak in a rural school from a remote

area of Yunnan Province was reported. In this area, median annual income was less than 200 USD. As 90% of Yunnan Province is mountainous and overall development in Yunnan was still low, the conditions in this setting were by no mean rare. Therefore, we conducted an investigation to define risk factors and to determine and implement the practical and affordable control measures.

Methods

Descriptive Study

A descriptive study was carried out among students of grade 1-9 in the rural school, Yunnan Province, China. Cases were students with generalized, vesicular pruritic rash lasting three or more days from 1 Aug to 14 Dec 2006.

Primary case was defined as the first case in a classroom or dormitory. The SAR was calculated by the formula below.

$$\frac{\text{Number of chickenpox cases in the second generation (21-42 days after the primary case in each classroom or dormitory)}}{\text{Number of total students in classroom or dormitory (exclude first generation cases and students with varicella history)}} \times 100$$

A standardized questionnaire was developed to obtain information on demographic data, symptoms, behavior, vaccination history and chickenpox history. Classrooms, dormitories, cafeteria and toilets were assessed for sanitation, ventilation and crowding condition. Cases were identified through school health records and active case finding was conducted through a school teacher. Self-administered questionnaires were used to collect information from students in grades 5-9 while students in preschool and grade 1-4 were interviewed face to face by using questionnaires. Students who lived in the dormitory were defined as boarding students and the rests were non-boarding students. Varicella vaccination history was confirmed by acquiring information from teachers and local health workers. As chickenpox cases have typical and pathognomonic signs to be diagnosed by physicians, laboratory study was not performed in this investigation.

Retrospective Cohort Study

Retrospective cohort study was conducted to define the differences of having potential risk factors between ill and non-ill students. Ill students were students with generalized, vesicular pruritic rash lasting three or more days in the rural school from 1 Aug to 14 Dec 2006 in order to trace back twice of the longest incubation period before onset of the first case. Non-ill students were those did not have generalized, vesicular pruritic rash lasting three or more days in the same school of the ill students during the same period. Univariate analyses comparing data of ill students with non-ill students on demographic, environmental, behavioral and care giving activities were calculated by chi-square test. Relative Risk (RR), Attributable Risk Fraction (ARF) and Population Attributable Risk Fraction (PARF) were calculated as well. Logistic regression models using the Stata program were employed to calculate RR and 95% CI. To control confounding factors and determine the important exposures, a multivariable model was created with significant P-value in univariate analysis (≤0.05), potential confounders and interaction terms. A backward elimination procedure was used to identify significant interaction terms and exposures that were the most strongly associated with incidence of chickenpox infection.

Results

There were 604 students, 16 classes and 10 dormitories in the affected rural school. Total 564 students (93.4%) participated in this study. Of which, none of them had received varicella vaccination before and 145 (25.7%) had history of past infection. There were 236 students met the case definition. The overall attack rate was 56% (236/419) among students without prior infection (Figure 1).

Symptoms included fever (55.8%), headache (48.0%) and sore throat (43.8%) (Figure 2). The mean age of the cases was 8.8 years, with SD 2.5 years. Attack rates were higher in younger age groups (80.2% in 5-7 years, 75.0% in 8-10 years) than in older groups (31.9% in 11-13 years, 18.6% in 14-17 years) (Figure 3). However, the attack rates were almost the same among boarding (56.3%) and non-boarding students (56.7%). Sex specific attack rates were 53.0% among males and 60.6% among females.

To understand transmission of the outbreak better, the cases identified during early stage of the outbreak were plotted by class and dormitory. Before 26 Oct, although most cases were from two classrooms, these cases were living in five different dormitories (Figure 4, 5, 6). SARs among students in each classroom and dormitory were calculated and the results did not show any marked difference (Table 1, 2).

In univariate analysis, close contact with cases (RR 1.6, 95% CI 1.3-2.0), touching chickenpox lesions (RR

1.8, 95% CI 1.6-2.0) and sharing towel with others (RR 1.3, 95% CI 1.0-1.6) were revealed to be risk factors. Hand washing (RR 0.7, 95% CI 0.6-0.8) was resulted to be protective. On the contrary, sharing towel with others and touching chickenpox lesions had a low PARF of 0.03 and 0.09 respectively, comparing with close contact (0.27) and hand washing (-0.29).

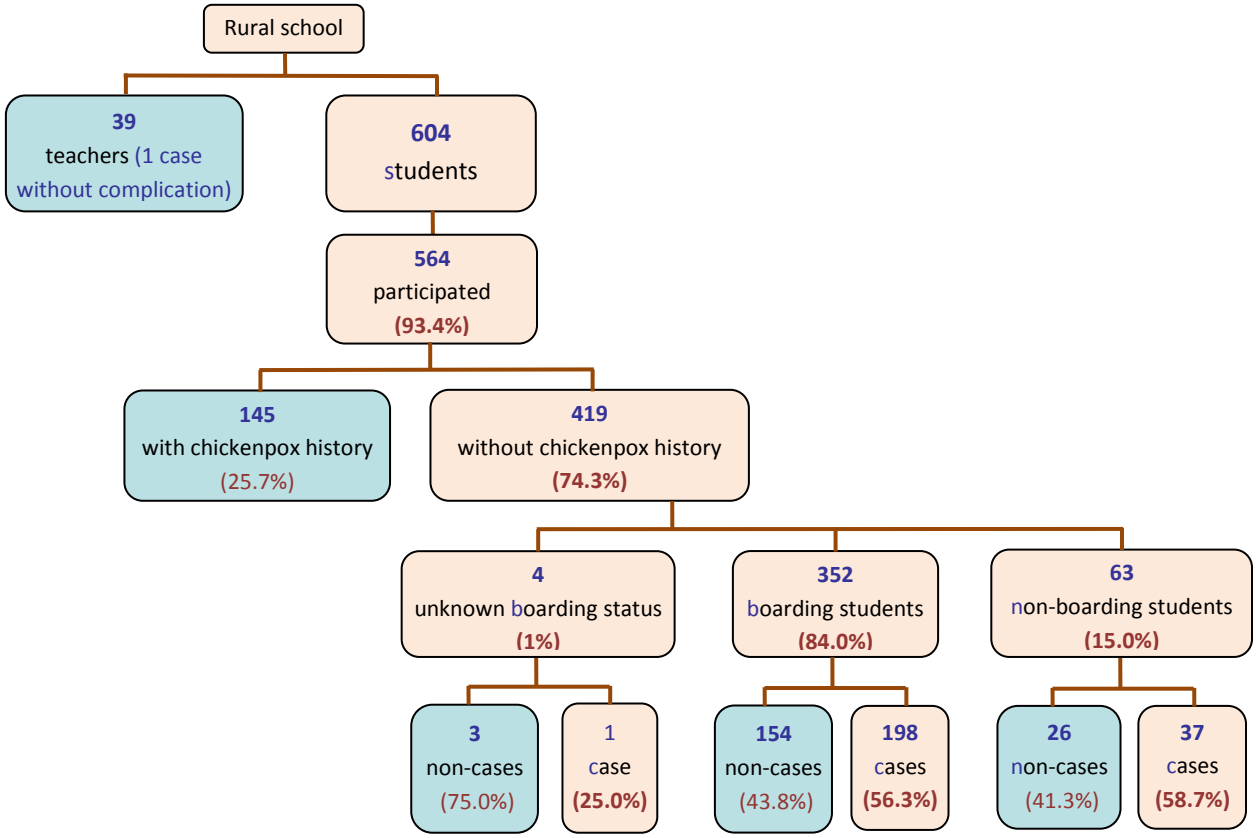

Figure 1. Number of cases and attack rates of varicella infection among students in the rural school, Yunnan Province, China, 2006

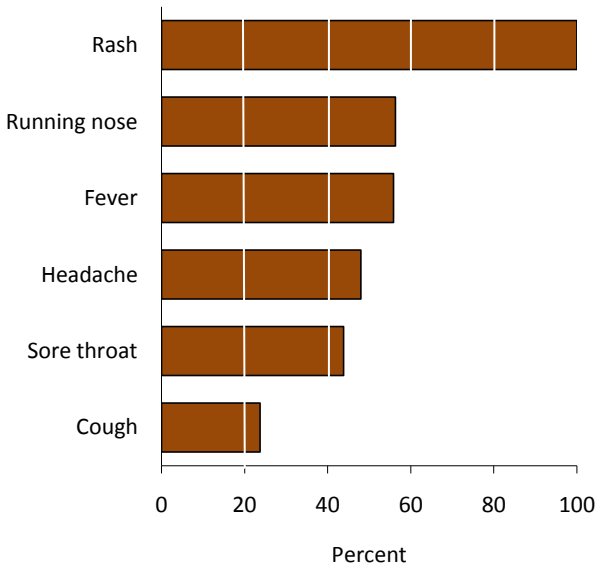

Figure 2. Clinical manifestations of varicella cases in the rural school, Yunnan Province, China, 2006 (n=563)

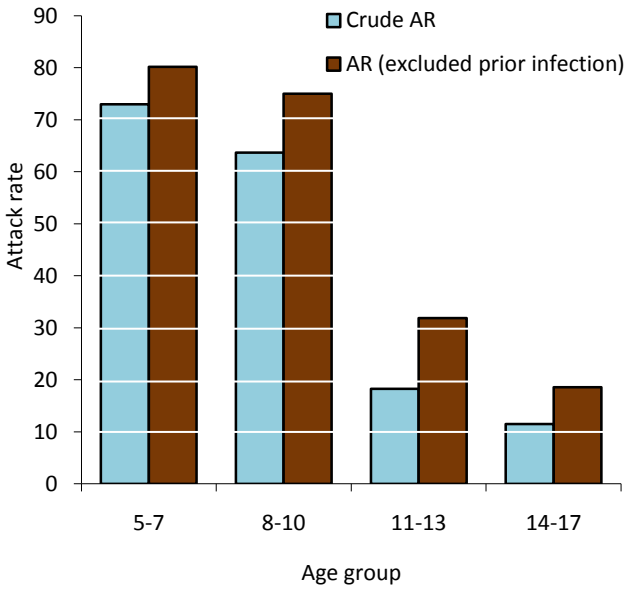

Figure 3. Attack rate by age group of varicella cases in the rural school, Yunnan Province, China, 2006 (n=563)

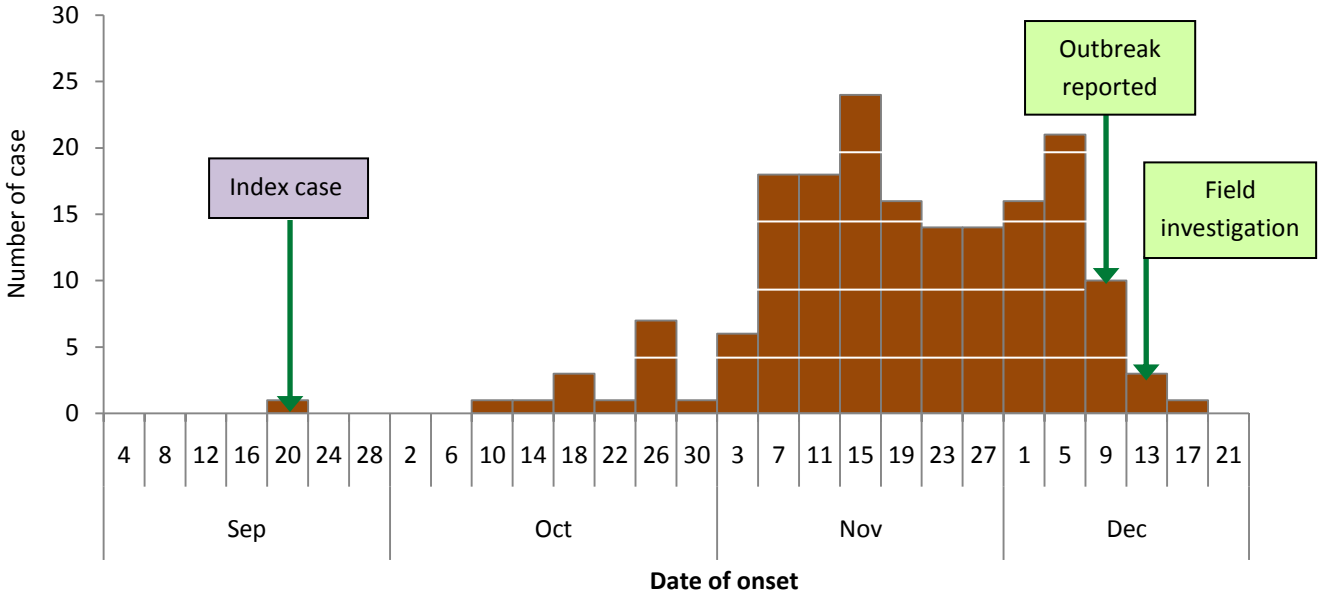

Figure 4. Number of varicella cases by date of onset in the rural school, Yunnan Province, China, 2006 (n=176)

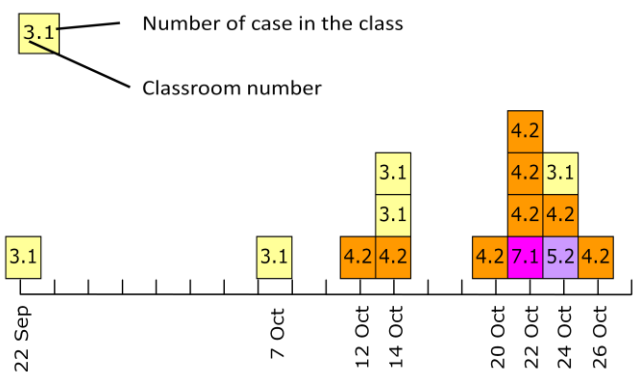

Figure 5. Distribution of varicella cases in the early stage by date of onset and classroom in the rural school, Yunnan Province, 22 Sep-26 Oct, 2006 (n=15)

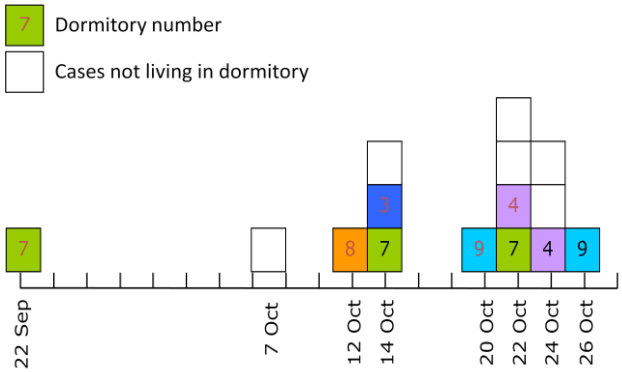

Figure 6. Distribution of varicella cases in early stage by date of onset and dormitory in the rural school, Yunnan Province, 22 Sep-26 Oct, 2006 (n=15)

Table 1. Number of varicella cases and attack rates by dormitory in the rural school, Yunnan Province, China, 2006

Dormitory	Number of case	Students without chickenpox history in dormitory			Secondary attack rate (%)
		Number (total number in dormitory)	Mean age (SD)	AR (%)	
1	4	16 (28)	14.6 (2.7)	25.0	20.0
2	4	5 (10)	9.6 (2.5)	80.0	33.3
3	7	13 (15)	11.1 (1.7)	53.9	8.3
4	10	18 (18)	10.9 (1.9)	55.6	35.7
5	20	38 (52)	10.4 (3.6)	52.6	11.1
6	17	30 (54)	11.2 (2.9)	56.7	29.2
7	20	27 (39)	8.7 (1.8)	74.1	44.0
8	10	21 (28)	9.3 (2.1)	47.6	35.0
9	20	35 (42)	10.8 (1.7)	57.1	21.9
10	10	37 (46)	11.7 (2.4)	27.0	9.1
Total	122	240 (332)	10.1 (3.0)	50.8	23.4

Table 2. Number of varicella cases and attack rates by class in the rural school, Yunnan Province, China, 2006

Grade	Class	Number of case	Students without chickenpox history in the class			Secondary attack rate (%)
			Number (total number in dormitory)	Mean age (SD)	AR (%)	
Pre-school		28	33 (33)	5.7 (0.5)	84.8	13.3
1	1	21	29 (31)	6.8 (0.8)	72.4	7.1
	2	23	29 (31)	6.1 (0.9)	79.3	/
2	1	27	34 (34)	8.4 (1.1)	79.4	10.5
3	1	27	29 (34)	9.0 (0.6)	93.1	34.6
	2	24	30 (36)	9.2 (0.9)	80.0	22.2
4	1	21	34 (36)	10.0 (0.9)	61.8	20.0
	2	18	26 (34)	9.8 (0.8)	69.2	/
5	1	10	21 (30)	11.0 (0.8)	47.6	31.3
	2	10	22 (32)	10.5 (0.5)	45.5	25.0
6	1	1	10 (20)	12.3 (0.5)	10.0	/
	2	3	14 (28)	11.6 (0.9)	21.4	/
7	1	7	27 (40)	12.9 (0.8)	25.9	9.1
	2	4	20 (40)	12.8 (1.0)	20.0	/
8	1	8	32 (54)	13.9 (1.0)	25.0	17.2
9	1	4	29 (51)	15.9 (0.9)	13.8	7.1
Total		236	419 (564)	10.1 (3.0)	56.3	13.1

Table 3. Univariate analysis of risk and preventive factors for varicella infection in the rural school, Yunnan Province, China, 2006

Factor	Expose		Non-expose		RR (95%CI)	Attributable risk fraction	Population attributable risk fraction
	Ill	Non-ill	Ill	Non-ill			
Hand washing	162	154	72	27	0.7 (0.6, 0.8)	-0.42	-0.29
Close contact	166	87	60	86	1.6 (1.3, 2.0)	0.37	0.27
Age less than 10 years	152	35	82	143	2.3(1.9, 2.7)	0.55	0.35
Sharing towel	30	13	202	163	1.3 (1.0, 1.6)	0.21	0.03
Touching chickenpox lesions	44	4	178	169	1.8 (1.6, 2.0)	0.44	0.09
Sharing clothes	12	5	218	164	1.2 (0.9, 1.7)	0.19	0.01
Sharing nail clipper	15	20	218	152	0.7 (0.5, 1.1)	-0.37	-0.02
Boarding	196	148	37	26	1.0 (0.8, 1.3)	-0.03	-0.03

Table 4. Comparison on risk and preventive factors of varicella infection by age group in the rural school, Yunnan Province, China, 2006

Factors	Number (%)		P-value
	< 10 years	≥ 10 years	
Close contact	134 (74.9)	118 (53.9)	<0.001
Hand washing	126 (68.1)	190 (83.0)	<0.001
Sharing clothes	6 (3.3)	11 (5.1)	0.37
Sharing nail clipper	9 (4.8)	26 (11.9)	0.01
Sharing towel	18 (9.7)	24 (10.8)	0.72
Touching chickenpox lesions	17 (9.7)	31 (14.2)	0.17
Boarding	150 (80.6)	193 (87.7)	0.05
Total	187	231	

It was found that the younger age group (<10 years) had higher risk than the older age group (RR 2.3, 95% CI 1.9-2.7) (Table 3). We compared risk and preventive factors among age groups. We found that the younger age group had more close contact with patients and less practice of hand washing (Table 4).

Table 5. Multivariate analysis of risk and preventive factors of varicella infection in the rural school, Yunnan Province, China, 2006

Risk Factors	Adjusted odds ratio	95% CI	
		Low	High
Close contact	2.5	1.6	4.0
Touching chickenpox lesion	17.8	4.0	78.3
Gender	0.6	0.4	1.0
Sharing towel	0.8	0.3	2.1
Hand washing	0.4	0.2	0.7

Multivariate analysis was done by using logistic regression. After we introduced convertible factors into multivariate analysis model, close contact with cases (Adjusted OR 2.5, 95% CI 1.6-4.0) and touching chickenpox lesions (Adjusted OR 17.8, 95% CI 4.0-78.3) remained as risk factors. Hand washing (Adjusted OR 0.4, 95% CI 0.2-0.7) was still a protective factor (Table 5).

Discussion

Chickenpox is not a notifiable disease in China and abnormal increase of cases cannot be detected by the case-based system of the web-based general infectious diseases surveillance system. Moreover, it is a self-limited disease and not commonly fatal. Therefore, awareness of teachers and village health providers in this chickenpox outbreak was quite low. Consequently, it was one of the reasons for delayed report and investigation. However, a chickenpox outbreak can be detected as an event and needs a rapid response once it occurs. Chickenpox outbreak in a school is defined as 10 or more cases, or one fatality of chickenpox infection occurred in a school within seven days.[4]

Chickenpox is a disease with less questionable on diagnosis as it can be diagnosed by clinical manifestations. Therefore, laboratory investigation may not be necessary in order to identify the cause of outbreak and confirm the cases. No severe case was found in this investigation probably due to no immunocompromised person in this school such as infants and elderly. Acyclovir should be administrated to both immunocompromised patients as treatment of choice and susceptible host with compromised immune system to prevent progression of the disease.[5] Another reason was likely that unnecessary supportive treatment was not provided as in developed countries. In United States, three children died from chickenpox infection during 1997.[6] When the children had high temperature and were admitted to hospital in developed countries, multiple drugs were given such as antibiotics, analgesics, antipyretics, steroids and antiviral medicines. Their condition could even deteriorate by doing so as intensive allopathic therapy could increase risk of developing complications. In this outbreak area, there was limited health facilities and also limited transportation.

Attack rates between boarding students and non-boarding students were similar. SAR by classroom and dormitory did not show any significant difference. Students who reported to have close contact with cases in both classroom and dormitory were observed by investigators in order to make sure the contact among them. We could imply that transmission had occurred in both classrooms and dormitories. At the early stage of the outbreak, cases were mainly from two classes who were living in five different dormitories. All classrooms and dormitories were already affected at the time of investigation. These facts suggested that living together with infected cases in the same room could facilitate spreading of the disease.

Information bias including recall and misclassification bias might occur for the information about prior infection and preventive and risk behaviors. Even though students from grade 5-9 could misunderstand some questions in the questionnaire, we did not have any opportunity to take sample and recheck those self-reported questionnaires with parents and teachers.

Varicella vaccination had a low coverage in China, even in developed areas. Vaccine coverage was only 23% among children aged less than six years in Shanghai during 2002.[7] It was not surprising that the affected population in this outbreak had zero coverage as the vaccine was expensive for these students and there was no support from the EPI program. Moreover, varicella vaccine might not be highly effective. Several studies reported that effectiveness of the vaccine against the infection was 72-86%[8-10] and even a study reported to be only 44%.[11] In addition, studies in the United States showed that even 80-97% vaccine coverage still could not prevent outbreaks in schools or day care centers.[8,10] Limited duration of protection also compromises its use for prevention of future outbreak as a study showed that its effectiveness reduced 6.7 times after five years of injection.[8]

Results of the analytic study showed that hand washing was a protective factor while close contact and touching chickenpox lesions were risk factors. Mixed living condition and behavior of young students implied that close contact among students were common. Chickenpox cases can transmit the infection even two days before skin lesions appear. Just avoiding close contact with patients could not assure the prevention. Isolation of cases was not considered as a control measure as its effectiveness was reported to be limited on outbreak control by More et al,[3] and also it was difficult to implement in this setting since majority of students were living in crowded dormitories. Family isolation of chicken pox patients is recommended by some health authorities, and avoiding exposing susceptible persons especially immunocompromised host to patients was emphasized.[12] However, it is not considered as a

measure of choice in this outbreak as students' families were far from the school and there was no convenient method to contact patients' guardians and deliver necessary health education. Hand washing was more important than touching lesions as its PARF (-0.29) was greater than that of touching lesions (0.09). Since hand washing requires almost no extra resources, hand washing is a feasible and economical method to implement in schools from rural areas. Although this investigation was conducted almost near the end of school term, attack rate could be as high as more than 90% among susceptible individuals as it is highly contagious.[1] We could attribute the rapid subsidence of the outbreak to our effective control measures.

Conclusion and Recommendations

This outbreak occurred in a remote rural school where the chickenpox vaccine had zero coverage due to its cost. The outbreak report was delayed since chickenpox is not a notifiable disease, and awareness among teachers and local health care providers was rather low. Education and training was needed for teachers and health care providers in this area to raise the awareness on infectious diseases. The transmission occurred in both classrooms and dormitories. Close contact were common among young students who shared the rooms with students from other classes. Given the fact that hand washing had a higher PARF and almost no cost to implement, it was promoted as a primary control measure in this outbreak. Health education on avoidance of close contact with cases, especially touching chickenpox lesions was also implemented. The effectiveness of the control measures was proved by rapid subsidence of the outbreak. Therefore, we recommend that hand washing is an effective and affordable control measures for this setting.

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Suggested Citation

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