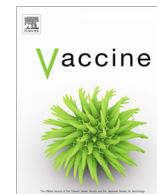




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# Effectiveness of post-exposure prophylaxis during varicella outbreaks among primary and middle school students in Shanghai: An analysis of three-year surveillance data <sup>☆</sup>

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## ABSTRACT

**Objectives:** To evaluate the effectiveness of post-exposure prophylaxis conducted during varicella outbreaks among students in Shanghai.

**Methods:** Surveillance data were collected from September 1, 2013 to December 31, 2016 involving 3524 susceptible students in 109 primary and middle school classes where emergency vaccinations (EVs) had been administered. Students were divided into two groups according to their prior vaccination (PV) varicella vaccine status. A secondary attack rate was used to compare EV and non-EV groups using a chi-squared test. Stratification analyses were performed, adjusting for the EV administration date, the vaccination coverage rate, and the number of cases prior to the EV.

**Results:** The effectiveness rate was 92.2% (95% confidence interval (CI): 37.1–99.0%) when EV was applied within 3 days following the outbreak onset date, and 95.2% (95% CI: 79.9–98.8%) when vaccination coverage was  $\geq 80\%$  among students with PV. When students with PV received an EV for varicella within 3 days, the effectiveness rate was 100%.

**Conclusions:** EV showed high protective effectiveness for varicella during outbreaks, especially if administered within 3 days of an outbreak and in conjunction with a high coverage rate.

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## 1. Introduction

Varicella is an acute and highly contagious disease, with symptoms generally appearing between 10 and 21 days after having been infected [1]. In highly populated settings, such as schools, varicella outbreaks are more likely. A varicella outbreak is defined as two or more varicella cases occurring within a 21-day period. Based on conservative estimates, the global annual varicella disease burden comprises 4.2 million severe complications leading to hospitalization and 4200 deaths [1]. The varicella vaccine, first developed in 1974 [2], is an important prevention method. It successfully reduced 80% of varicella cases among both vaccinated and unvaccinated residents following its introduction in the United States [3].

The varicella vaccine has been licensed in China since 1998. A one-dose regime has been used for the  $\geq 1$ -year-old population who receive only one dose of the vaccine in their lifetime [4]. Since the varicella vaccine has not been introduced into the National Immunization Program of China, it is administered as a voluntary vaccination, once parents or guardians of children have provided informed consent. Coverage of the one-dose varicella vaccine in China has been reported to be 73.6% [5], while eastern and more developed regions [6,7] report a higher rate (approximately 90%). However, although most children have been vaccinated and the effectiveness of the one-dose vaccination has been verified in clinical settings in China [8], schools in China have continuously experienced and reported varicella outbreaks [9–12], usually affecting primary and middle schools [13,14]. The World Health Organization has reported that this situation may be due to waning immunity or secondary vaccine failure [15].

An emergency vaccination (EV) is an effective post-exposure prophylaxis (PEP) used to control varicella outbreaks. The US Advisory Committee on Immunization Practices has recommended that an EV administered within 3–5 days after exposure would be

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highly effective for the prevention of moderate or severe symptoms due to varicella [1,16]. A recent systematic review concluded that the varicella vaccine, when administered to children following household contact with a varicella case, reduced infection rates and severity in the cases reported [17].

In China, Beijing was the first city to introduce the varicella vaccination as a PEP [18]. Since 2013, Shanghai local authorities have launched EVs to control varicella outbreaks. The effectiveness of EVs in China has only been evaluated in two studies [19,20]. One study provided data for just one outbreak [19] and in another study, the outbreak occurred within a very short timeframe [20]. Our study assessed the effectiveness of an EV, and analyzed a large-scale population sample that comprised all outbreaks as identified in surveillance data from 2013 to 2016 in the Hongkou District of Shanghai.

## 2. Methods

### 2.1. Study population

From September 1, 2013 to December 31, 2016, EVs for varicella have been administered in 51 schools during outbreaks, defined as having two or more varicella cases within a 21-day period. In this study, we selected the classes where students had been administered an EV for analysis. The study population comprised 3524 susceptible students from 109 classes, who had been exposed to varicella cases (with or without a previous vaccination history). We excluded 102 students with a varicella history and 283 primary cases involving a disease onset date prior to or at the time of EV implementation. The coverage rate for the one-dose varicella vaccine among the study population was 81.3% (2864/3524).

### 2.2. Study design

The study sample was divided into two groups according to a history of prior vaccination (PV) to minimize the effect of a PV

on protecting the participants from infection during the outbreaks. The varicella secondary attack rate (SAR) was compared between the EV (those who received an EV) and non-EV groups (those who did not receive an EV) (see Fig. 1).

### 2.3. Emergency vaccination program procedure

The EV was administered in three steps. First, the Center for Disease Control and Prevention (CDC) in Hongkou District obtained permission for an EV from the District Health and Family Planning Commission. Second, the students' guardians provided written informed consent, using forms distributed by the Shanghai Municipal CDC. Third, students were scheduled to receive one dose of varicella vaccine if they met all three of the following criteria: no history of varicella, no history of having been vaccinated within the previous 5 years, and no apparent contraindications to the varicella vaccine. Vaccines were purchased and allocated by the Shanghai Municipal CDC, and were offered by local community immunization centers to the students free of charge.

### 2.4. Data collection

Healthcare professionals in the schools, in addition to staff from local community immunization centers, investigated the varicella outbreaks and collected the relevant data. Staff from Hongkou District CDC checked the collected data and participated in the investigation when there was five or more varicella cases involved in the outbreak. All members involved in the investigation and those undertaking data collection participated in annual training for data quality control. All cases of varicella were diagnosed and confirmed by doctors from tertiary and regional hospitals, with the dates of diagnosis documented separately in a school electronic surveillance system. Further, we collected data on the varicella vaccination status of students, obtained from their immunization records, and from guardians providing information on prior varicella history through phone interviews conducted with school healthcare professionals.

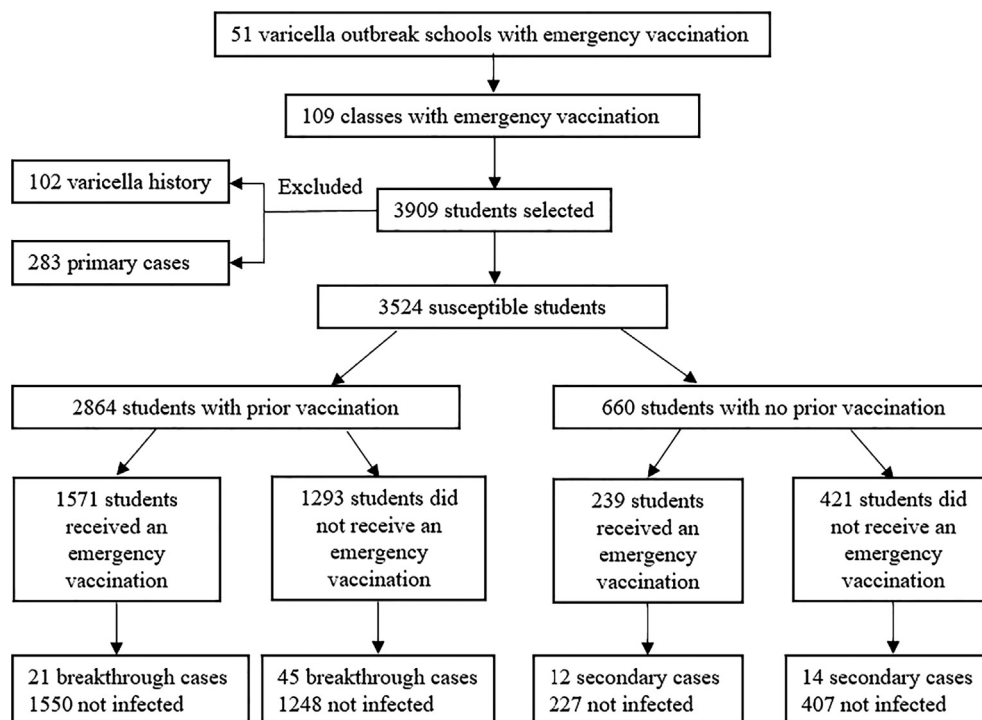


Fig. 1. Study design and study selection process.

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