

An Elementary School Outbreak of Varicella Attributed to Vaccine Failure

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ABSTRACT

Background: Since U.S. licensure, studies have shown the varicella vaccine's overall effectiveness to range from 44-100%, with substantial protection against moderate and severe varicella; however, breakthrough disease has been documented in up to 56% of vaccinated individuals.

Methods: A varicella outbreak occurred in a Minnesota school with 319 students. Phone surveys were conducted with students' parents. Information was collected on students with recent varicella infections including onset date, rash characteristics, duration, and underlying medical conditions.

Results: Fifty-four cases occurred following a primary, breakthrough case. Twenty-nine (53%) cases were vaccinated. Unvaccinated students had an increased risk of moderate varicella compared to vaccinated students (RR, 4.4; 95% CI, 2.2 to 9.1, p<0.001). The vaccine was 56% effective at preventing any varicella and 90% effective against moderate illness. Students vaccinated five or more years prior to the outbreak had a greater risk of breakthrough varicella compared to those vaccinated within four years (RR, 2.6; 95% CI, 1.3 to 5.4, p<0.01).

Conclusions: Vaccinated students presented with milder varicella symptoms than unvaccinated students. Individuals with breakthrough disease can be highly infectious. Time since varicella vaccination was associated with illness. Despite 29 breakthrough cases, the varicella vaccine conferred a high degree of protection against moderate illness.

BACKGROUND: VARICELLA-ZOSTER

- Before vaccine licensure in the United States, varicella disease accounted for an estimated 4 million cases, 11,000 hospitalizations, and 100 deaths annually.^{1,2}
- Median incubation period for varicella illness is 14 to 16 days (range, 10 to 21 days).
- Transmission occurs by person-to-person contact and by airborne secretions from the mouth, nose, and throat.
- A live, attenuated vaccine was developed in Japan in 1974 and approved in the United States in 1995.^{1,2,3}
- Recent studies have suggested that immunity from the varicella vaccine may wane over time.^{5,6}

BACKGROUND: OUTBREAK

- The Minnesota Department of Health was notified of a school-based outbreak of varicella in November 2002.
- Cases were identified in students attending a public elementary school in northern Minnesota.
- 307 students were in attendance during the outbreak, including preschool, kindergarten, and grades one through five.

Table 1. Selected Demographics of Interviewed Students at Elementary School A at the Time of the Outbreak

	Students with Varicella (n=55)	Students without Varicella (n=194)	Attack Rate ^a , %
Susceptibility Status			
Unvaccinated (n=36)	20	16	56
Vaccinated (n=118)	29	89	25
Prior History (n=95)	6	89	6
Grade -- no.			
Preschool	0	11	0
Kindergarten	12	29	29
1 st	13	29	31
2 nd	13	30	30
3 rd	8	25	24
4 th	6	36	14
5 th	3	34	8
Female -- no. (%)	31 (56)	105 (54)	--
Time at School			
Median (hours/week)	35	36	--
Range	18 - 49	10 - 58	--

^a Attack Rate: students w/ varicella / (students w/ varicella + students w/o varicella)

METHODS

- Parents of students were interviewed by phone. The amended CDC varicella outbreak questionnaire included:
 - Demographic information
 - Extracurricular activities
 - Time spent at the school
 - Medical history
 - Illness history of students with outbreak-associated varicella

- Follow-up was conducted with clinics by verifying dates of immunization(s) and obtaining vaccine lot numbers, if available.

CASE DEFINITION

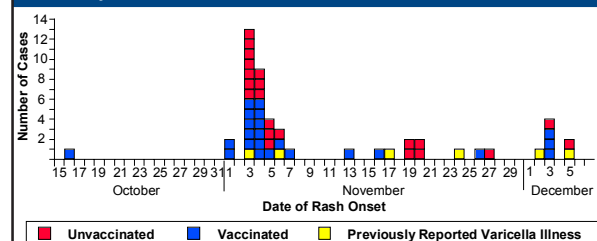
- Cases were defined by having an acute maculopapulovesicular rash with no apparent cause during the 6 months preceding the investigation.
- Students were classified into three groups:
 - Prior history of varicella illness
 - Vaccinated, no prior varicella illness
 - Unvaccinated, no prior varicella illness
- Severity was classified based on the number of lesions reported:^{4,5,7}
 - <50 lesions was a mild case of varicella illness
 - 50 to 500 lesions was a moderate case
 - >500 lesions was a severe case

Table 2. Selected Risk Factors for Breakthrough Varicella among Vaccinated Students

Characteristic	Students with Varicella (n=29)	Students without Varicella (n=89)	Relative Risk (95% CI)	P Value
Age at Outbreak Onset				
Median (years)	7	7		0.31 ^b
Range	5 - 11	4 - 11		
Vaccination Age				
12 to 15 Months	17	30	2.1 (1.1 - 4.1)	0.03 ^a
>15 Months	12	59		
Median (months)	15	20		0.04 ^b
Range	12 - 93	12 - 87		
Time since Varicella Vaccination				
5 years or more	21	38	2.6 (1.3 - 5.4)	<0.01 ^a
4 years or less	8	51		
Median (years)	5	4		<0.01 ^b
Range	2 - 7	0 - 7		
Asthma				
Yes	1	6	0.6 (0.1 - 3.6)	0.99 ^a
No	28	83		
Chronic Ear Infections				
Yes	10	16	1.9 (1.0 - 3.5)	0.07 ^a
No	19	73		
Other Lung Problems				
Yes	4	2	3.0 (1.5 - 5.8)	0.03 ^a
No	25	87		

^a Fisher's Exact Test and ^b Wilcoxon Rank-Sum Test used for two-sided P values

Figure 1. Cases of Varicella among Students Attending Elementary School A, by Date of Rash Onset* and Vaccination Status, Minnesota 2002



*Date of Rash Onset Missing for Five Students

RESULTS

- 252 (82%) of 307 students were interviewed, three interviewed students were excluded since they received the varicella vaccine <12 months of age (Table 1).

- 55 varicella cases occurred during the outbreak, which lasted from October 16 to December 5, 2002 (Table 1, Figure 1).

- The varicella vaccine was 56% effective at preventing varicella entirely and 90% effective at preventing moderate varicella symptoms (calculations not shown).

- Length of time since varicella vaccination was associated with illness (Table 2, Figure 2).

- Age at receiving the varicella immunization was identified as a risk factor for varicella illness (Table 2).

- Time spent at school and extracurricular activities were not significant risk factors.

- No relationship between history of asthma and breakthrough varicella was identified (Table 2).

- Receiving other vaccines within 30 days of the varicella vaccine was not identified as a risk factor for varicella illness.

- There were no patterns identified between varicella vaccine lot numbers and breakthrough varicella.

- Vaccinated cases did present with a more mild form of the illness than unvaccinated cases (Table 3).
 - Fewer lesions
 - Less likely to have a fever
 - Shorter duration of illness
 - Missed fewer days of school

Figure 2. Length of Time Since Varicella Immunization, among Vaccinated Students with No Prior History of Varicella

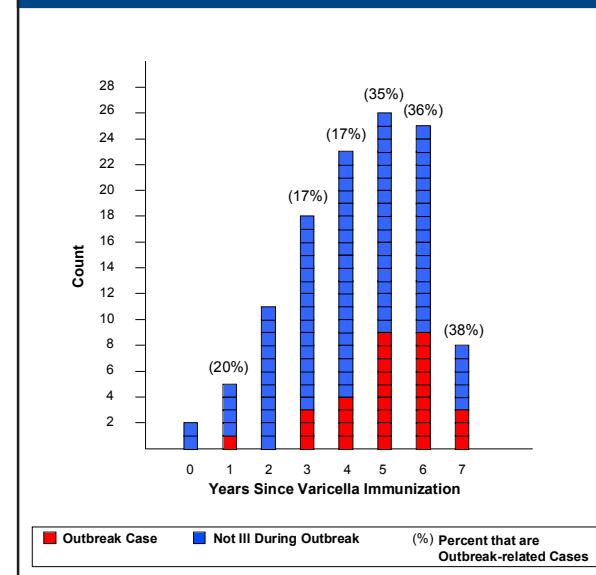


Table 3. Characteristics of Illness among Cases Without Prior History of Varicella, By Vaccination Status

Characteristic	Vaccinated Students ^a (n=29)	Unvaccinated Students (n=20)	Relative Risk (95% CI)	P Value
Number of Lesions				
50 to 500	6	19	4.4 (2.2 - 9.1)	<0.001 ^b
Less than 50	22	1		
Parental Report on Illness Severity				
Mild	5	4	4.5 (2.0 - 10.2)	<0.001 ^b
Moderate	23	16		
Lesion Location				
Entire body	10	17	2.4 (1.4 - 4.0)	0.001 ^b
Torso/Head region	18	3		
Duration of Illness				
Median (days)	3	4		0.02 ^c
Range	0 - 7	1 - 9		
Days of School Missed				
Median (days)	3	4		0.008 ^c
Range	0 - 5	1 - 17		
Fever				
Yes	13	18	1.8 (1.2 - 2.7)	0.005 ^b
No	13	2		
Measured Temperature				
Median (°C)	37.8	38.9		0.004 ^c
Range	37.2 - 38.3	37.8 - 40		
Attack Rate (%)	24.6	55.5		<0.002 ^b

^a Data on all characteristics missing for one student

^b Fisher's Exact Test and ^c Wilcoxon Rank-Sum Test used for two-sided P values

LIMITATIONS

- Interviews were conducted with parents, thus assessment of varicella illness was not validated by a physician.
- Recall bias was possible since the outbreak investigation occurred 1-2 months following the last varicella case.

IMPLICATIONS

- First documented varicella outbreak in an elementary school setting with a vaccinated primary case.
 - Breakthrough cases are still contagious
 - School/Daycare exclusion recommended for breakthrough cases while ill
- The varicella vaccine demonstrated a high degree of effectiveness against moderate varicella illness.
- Breakthrough cases presented with a significantly milder form of varicella illness than unvaccinated cases.

DIRECTIONS FOR THE FUTURE

- Further evaluation of varicella effectiveness and risk factors for breakthrough illness.
- Continue to increase the national varicella immunization coverage level.
 - Educating parents and physicians on the benefits of the varicella immunization
- Assess if administering a booster dose will offer additional protection.

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