

Varicella Screening and Vaccination for Healthcare Workers at KK Women's and Children's Hospital

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Abstract

Introduction: Varicella is a highly contagious disease with significant morbidity and mortality, especially in adults. It can lead to nosocomial transmission with dire consequences, especially in a healthcare facility where children and pregnant women form the majority of patients. At KK Women's and Children's Hospital, we embarked on a programme in 2 phases, between 1997 and 1999, to screen healthcare workers (HCWs) for varicella immunity and to offer varicella vaccination to those who tested negative for antibody. **Materials and Methods:** HCWs were initially screened via a questionnaire; those with no previous history of chickenpox underwent a blood test for varicella zoster antibody. Varicella vaccine was offered to those who tested negative for antibody and they were monitored for adverse reactions. **Results:** Of the HCWs surveyed, 14.7% and 26.9% in phases 1 and 2, respectively, had no previous history of chickenpox. Of these, 55.3% in phase 1 and 26.1% in phase 2 tested negative for antibodies. Thus, the overall seronegativity of all HCWs surveyed was between 6.5% and 7.6%. Among those who tested negative for antibodies, 42.9% in phase 1 and 74% in phase 2 were vaccinated. Hence, the overall vaccination rate in HCWs was 3.2% and 4.8% in phases 1 and 2, respectively. Adverse reactions were observed in 2 (22.2%) HCWs in phase 1 and in 9 (9.3%) in phase 2, consisting mostly of maculopapular rashes or vesicles around the injection site. **Conclusions:** Our study shows that 26% to 55% of HCWs with no history of chickenpox and who tested negative for antibody against varicella required vaccination. Hence, in healthcare facilities, varicella screening and vaccination should be offered to all HCWs.

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Introduction

Due to the increased morbidity and mortality of varicella zoster (VZ) in adults and increased exposure to chickenpox in hospitals, especially in paediatric hospitals, healthcare workers (HCWs) are encouraged to be vaccinated against varicella.^{1,2} Pregnant HCWs who are exposed to chickenpox also face the risk of transmitting VZ to their foetus, who may develop congenital varicella embryopathy. HCWs who develop chickenpox can also transmit VZ to patients. This can result in devastating consequences in immunocompromised or pregnant patients.

Varicella vaccine was first licensed for use in Singapore in 1996. Although the majority of chickenpox cases occur in children <15 years old, 27.5% and 26.7% of chickenpox

cases occurred in adults >25 years old in 2001 and 2002, respectively (unpublished data for 2002 from National Environment Agency).³ HCWs who work closely with children, such as in paediatric hospitals, day-care centres or schools, are at increased risk of exposure to chickenpox. Many hospitals in the United States (US) and in other countries require HCWs to be screened and vaccinated against VZ. In our institution, we started a screening programme in 1997 for VZ in HCWs via a questionnaire interview, blood test for antibody against the virus in those with no previous history of chickenpox, and free vaccination to those who tested negative for the antibody. In this article, we report the results of the 2 phases of the screening programme.

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Materials and Methods

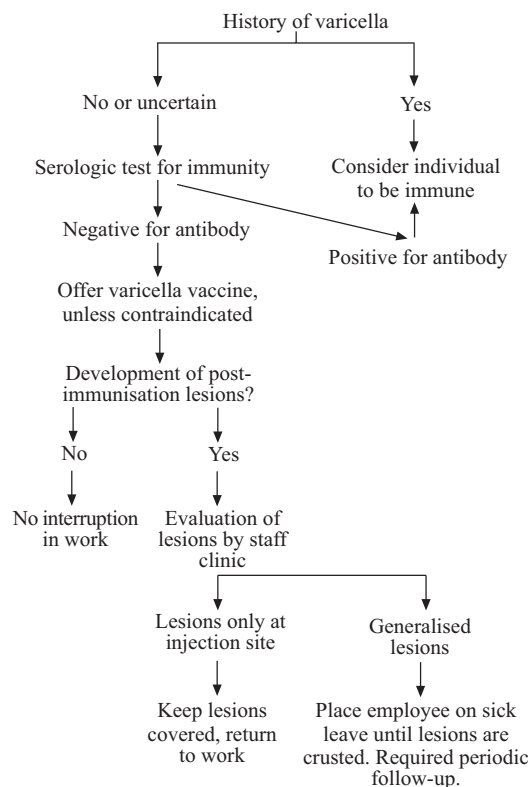
All HCWs employed in our institution were screened via a questionnaire on whether they had chickenpox previously or any vaccination against VZ. The HCWs included nurses, doctors (medical officers and above), paramedical staff (rehabilitation staff, diagnostic imaging staff, pharmacists, dieticians and laboratory personnel) and administrative staff, including health attendants. In phase 2, the screening programme included more people as the medical affairs department was mobilised to help in the programme. House officers were excluded from the programme due to their short working stint in our institution. However, they were advised by the Infection Control Unit to get themselves immunised if they lack the antibody against VZ. HCWs who had no history of chickenpox or prior VZ vaccination had their immune status determined by enzyme-linked immunosorbent assay (EIA) for VZ antibody. If they tested negative for antibody, they were given 2 doses of 0.5 mL Varivax (Merck, Sharp and Dohme, Westpoint, Pennsylvania, USA) subcutaneously 4 to 6 weeks apart. The costs of screening and vaccination were borne by the institution, except between January and March 1998 when the vaccine was supplied free by Merck, Sharp and Dohme. Varivax was used in both phases.

Phase 1 ($n = 278$) was carried out between July 1997 and February 1998 when the institution was newly opened. Phase 2 ($n = 2006$) was carried out between September 1998 and January 1999. The algorithm for screening and immunisation is shown in Figure 1. Follow-up of questionnaire replies, blood tests and vaccinations were conducted by infection control nurses. After vaccination, HCWs were advised to avoid using aspirin for 6 weeks, getting pregnant for 3 months and contact with high-risk patients (babies in the neonatal intensive care unit, pregnant women and oncology patients). HCWs were followed up for adverse effects of vaccination. If skin lesions developed, they would be evaluated by the staff clinic. If lesions were present only at the site of injection, these were to be covered and staff could return to work. However, if the lesions were generalised or vesicular, the staff would be granted medical leave until all lesions had dried up and became crusted.

Chi-square analysis was used to compare the 2 phases using the SPSS software version 9.0, with Fisher's exact test for correction. A P value of <0.05 was considered statistically significant.

Results

The results of the screening and vaccination uptake are shown in Table 1. Phase 1 involved more nurses and doctors. Administrative staff were only included in phase 2. The difference in surveillance rates among the staff accounted for most of the observed differences between the



Precautions

1. Avoid taking aspirin for 6 weeks after immunisation
2. Avoid pregnancy for 3 months after immunisation

Contraindications

1. Hypersensitivity to any vaccine components, including gelatin
2. History of anaphylaxis to neomycin
3. History of blood dyscrasias, leukaemia, lymphoma or other neoplasms
4. Receiving immunosuppressive therapy
5. Primary and acquired immunodeficiency states
6. Family history of congenital or hereditary immunodeficiency
7. Active, untreated tuberculosis
8. Any febrile respiratory illness or other febrile infection
9. Pregnancy
10. Blood or plasma transfusions or immunoglobulin products within last 5 months
11. Contact at home with persons having any of the above diseases

Fig. 1. Algorithm for use of varicella vaccine in healthcare workers.

2 phases. The proportion of HCWs with no previous history of chickenpox was 14.7% and 26.9% in phases 1 and 2, respectively ($P < 0.001$). Doctors had a higher rate of previous chickenpox compared to nurses and paramedical staff in phase 2 ($P < 0.001$). However, the difference in rates of previous chickenpox between nurses and paramedical staff was not significant in phase 1, but significant in phase 2 ($P = 0.032$). In both phases, 7% of HCWs refused the antibody test. In phase 1, 55.3% (21/38) of HCWs with no history of chickenpox and who agreed to the antibody test lacked the antibody against VZ. In phase 2, 26.1% (131/501) tested negative for antibody and the difference between phases 1 and 2 was significant ($P < 0.001$). The initial

Table 1. Comparison Between the 2 Phases of Screening and Uptake of Varicella Vaccine by HCWs

Variable	Phase 1 (%)	Phase 2 (%)
HCWs surveyed	278	2006
Nurses	184 (66.2)	1141 (56.9)
Doctors	60 (21.6)	181 (9)
Paramedical staff	34 (12.2)	244 (12.2)
Administrative staff	0	44 (21.9)
No previous chickenpox	41 (14.7)	539 (26.9)
Nurses*	20 (10.9)	293 (25.7)
Doctors*	14 (23.3)	28 (15.5)
Paramedical staff*	7 (20.6)	79 (32.4)
Administrative staff*	0	139 (31.6)
Tested negative for antibody [†]	21 (55.3)	131 (26.1)
Nurses [‡]	10 (50)	80 (27.3)
Doctors [‡]	8 (57.1)	3 (10.7)
Paramedical staff [‡]	3 (42.9)	20 (25.3)
Administrative staff [‡]	0	28 (20.1)
Given vaccine [§]	9 (42.9)	97 (74)
Nurses [§]	3 (30)	61 (76.3)
Doctors [§]	5 (62.5)	3 (100)
Paramedical staff [§]	1 (33.3)	12 (60)
Administrative staff [§]	0	21 (75)
Reasons for refusing vaccine		
Contraindicated	1	2
Pregnant	2	1
Requests deferral	3	2
Developed chickenpox	1	0
Refused consent	5	28
Not in service	0	1

HCWs: healthcare workers

Phase 1 was conducted between July 1997 and February 1998. Phase 2 was conducted between September 1998 and January 1999.

* Percentage of those in their respective occupation with no previous chickenpox.

[†] Percentage of those with no history of chickenpox, agreed to antibody test and tested negative ($n = 38$ in phase 1 and $n = 501$ in phase 2).

[‡] Percentage of those in their respective occupation with no history of chickenpox, agreed to antibody test and tested negative.

[§] Percentage of those who tested negative for antibody and were given vaccine.

[¶] Percentage of those in their respective occupation who tested negative for antibody and were given vaccine.

overall seronegativity of all HCWs surveyed was between 6.5% and 7.6%. There was a substantial difference in the uptake rate of vaccination between the 2 phases (42.9% and 74% in phases 1 and 2, respectively; $P = 0.004$). Of all HCWs surveyed at the start of the programme, 3.2% in phase 1 and 4.8% in phase 2 were vaccinated. A comparison of the responses between the occupational groups is shown in Table 2. For those with no previous chickenpox, there were significant differences between all occupations ($P < 0.001$ to $P = 0.035$), except when comparing paramedical and administrative staff.

In phase 1, 22.2% (2/9) of HCWs developed reactions to the vaccine. One staff nurse developed 4 pustules around the injection site on day 12, which subsided 4 days later without any fever; no reaction was seen with the second dose. Another pharmacist had no reaction to the first dose, but had severe headache after the second dose, which subsided the following day. In phase 2, 9.3% (9/97) of HCWs who were vaccinated developed adverse reactions to the vaccine. The difference in the adverse vaccine reaction rate between the 2 phases was not statistically significant. The majority (8 cases) of the reactions were maculopapular rashes, which occurred around the injection site between day 2 and 41 after vaccination. These lesions were described as “prickly heat” or warm and pruritic. One staff nurse developed a localised lesion around the injection site on day 12; on day 16, lesions appeared in the ear lobe, neck, back and abdomen. One doctor developed 6 vesicles on day 12 on the arm, abdomen and back. We were not able to confirm if the vesicles which occurred on day 12 in the 2 HCWs were due to vaccine virus or exogenous infection, as this required isolation of the virus and genetic sequencing. Although HCWs were advised to avoid contact with high-risk patients, logistically this was virtually impossible to do so. HCWs who developed vesicular rashes were the only ones furloughed.

Reasons for refusal of vaccination included worry about side effects of the vaccine, preference for natural immunity, fear of transmission of vaccine virus to family members who were immunosuppressed, belief that the vaccine was unnecessary or not important, disinterest and indecisiveness. Vaccination, follow-up of blood results and counselling

Table 2. Comparison of the Screening and Uptake of Varicella Vaccine by Occupation

Variable	Occupation				P value
	Nurses ($n = 1325$)	Doctors ($n = 241$)	Paramedical staff ($n = 278$)	Administrative staff ($n = 440$)	
No previous chickenpox (%)	313 (23.6)	42 (17.4)	86 (30.9)	139 (31.6)	<0.001
Tested negative for antibody* (%)	90 (28.8)	11 (26.2)	23 (26.7)	28 (20.1)	0.295
Given vaccine [†] (%)	64 (71.1)	8 (72.7)	13 (56.5)	21 (75)	0.494

* Percentage of those with no previous chickenpox who tested negative for antibody.

[†] Percentage of those who tested negative for antibody and were given vaccine.

were undertaken by infection control nurses. We did not perform a long-term follow-up of the HCWs for breakthrough varicella. After phase 2 of the study was completed, all new employees in the institution underwent a questionnaire screening in the human resource department and forms were sent to infection control nurses for advice on whether antibody screening was required. HCWs were then sent to the staff clinic or the designated family practitioners (after January 2002, when the staff clinic ceased operation) for serologic screening and vaccination. Further follow-up of those who refused either blood screening or vaccination was done at the ward levels.

Discussion

Chickenpox is a highly contagious infection caused by the VZ virus. Although it is more common in childhood, in Singapore 59% of chickenpox cases occurred in children <15 years old in 2002 compared to >90% in the US (unpublished data from the National Environment Agency). In our study, for HCWs with no history of previous chickenpox, 30% to 51% of them were non-immune. This is much higher than the rate found in temperate countries such as the US, where only 10% to 25% of HCWs were not immune.^{4,5} Studies done in the tropics have shown that at least 30% of adults remain vulnerable because of the lower efficiency in the spread of the virus in warm, humid climates.⁶ The overall seronegativity rate of 6.5% to 7.6% in all HCWs in our study is similar to that previously reported for Singapore between 1989 and 1990, when 2% to 14% of adults >25 years old were non-immune.⁷ Unfortunately, we did not collect any data on the ages of the HCWs and cannot distinguish between the seronegativity rates between the different age groups of HCWs. The difference between our study and the previous study can be attributed to the cyclical nature of community outbreaks and, hence, herd immunity as has been described in India, where community outbreaks occur once every 4 to 5 years.⁸ In Singapore, the epidemic cycles of chickenpox occur once every 3 years, with previous peaks in 1993, 1996, 1999 and 2002.³ However, the overall incidence rates of chickenpox have been decreasing steadily from 1993 to 2002.³ Although it can be argued that the HCWs in our institution included many foreigners, especially among the nursing staff, this finding may still be applicable to other healthcare facilities in Singapore, where foreign nurses constitute a significant proportion of the workforce in health care.

Various methods have been used to detect antibody against VZ, of which the fluorescent antibody to membrane antigen (FAMA) remains the most sensitive method. However, it is rather time-consuming. Latex agglutination assay and EIA are better alternatives than FAMA and complement fixation tests.⁹ EIA tests range in sensitivity

from 86% to 97% and in specificity from 82% to 99% in detecting antibody after natural infection.⁹ Thus, it is unlikely that seropositivity is low due to the type of test; rather, it is a true reflection of risk.

Adults have higher rates of complicated disease and, hence, more hospitalisations compared to children. The mortality rate for immunocompetent adults aged 30 to 49 years is 25.2 per 100,000 compared to 0.75 per 100,000 in children aged 1 to 14 years and 6.23 per 100,000 for infants <1 year old.¹⁰ Three fatalities were seen in 2001 and 1 in 2000 in Singapore; all were adults aged 36 to 60 years.³

The efficacy rate of vaccination against all forms of chickenpox is 70% to 90%. For severe chickenpox, it is 95%.¹¹ Among the HCWs, 26% to 57% refused vaccination despite counselling; this rate is similar to that of another study in the US, where 32% refused vaccination.¹² In view of the protection afforded by the VZ vaccine and the higher morbidity and mortality rates in adults, HCWs should be strongly encouraged to vaccinate themselves against VZ; exceptions may be made in those with contraindications.^{1,13} House officers and students who require vaccination should be covered by the university.

Nosocomial transmission between patients and HCWs and vice versa is common.² This is particularly troublesome in immunosuppressed patients, as this involves investigation of exposure and administration of varicella immunoglobulin. This results in considerable expense and disruption in work. In a brief report from the US, 43 immunosuppressed patients were exposed to 5 paediatric house officers who developed chickenpox and required varicella immunoglobulin.¹⁴ Immunosuppressed patients should ideally have staff caring for them who are immune to varicella.

The VZ IgG EIA test costs S\$27, whereas the vaccine costs S\$60 per dose or S\$120 for a 2-dose course. If 100 HCWs undertake the antibody test and 30% to 50% of them require vaccination, the costs would be $100 \times \text{S\$27} + 30 \times \text{S\$120} = \text{S\$6300}$ (for a 30% vaccination rate) or S\$8700 (for a 50% vaccination rate). If all 100 HCWs were vaccinated, the costs would be $100 \times \text{S\$120} = \text{S\$12,000}$. Screening antibody in those with no history of chickenpox is cheaper than mass immunisation. Varicella vaccination in HCWs has been shown to be cost-effective in previous studies.^{4,9,13,15} We did not examine the seroconversion rate after vaccination as the antibody response in adults and adolescents has been reported previously.¹⁶

Minor rashes were observed in 9.3% to 22% of HCWs after vaccination. The rate (22%) of adverse effects is due to the small number of vaccinees (2 out of 9) in phase 1. Full recovery without transmission of the vaccine virus was seen. Side effects of VZ vaccines have been reported, with the majority being immediate local injection site reactions or a localised or generalised rash occurring 10 to 21 days

after vaccination.¹ Transmission of vaccine virus worldwide has so far only been documented in 3 cases with a vesicular rash; all 3 cases resulted in mild disease without complications.¹ No evidence of loss of immunity after vaccination is seen, with >20 years of follow-up.¹⁷ However, re-exposure to wild-type virus may have contributed to this persistent immunity. HCWs are likely to experience re-exposures and their VZ antibody level may be boosted.

VZ vaccination is contraindicated in pregnant women. However, there have been no cases of congenital varicella despite inadvertent exposure during pregnancy.¹⁸

This is unlike natural infection during pregnancy, which can lead to varicella embryopathy in 2.2% of cases, clinical varicella in the newborn period or clinical zoster in infancy or early childhood.^{9,19} In our study, the HCWs were advised to avoid getting pregnant for the next 3 months; more recent guidelines suggest a 1-month interval between vaccination and pregnancy.^{10,13}

HCWs who refuse or, for medical reasons, are unable to receive the vaccine should be advised to wear masks and gloves when handling cases of infectious chickenpox or herpes zoster. Better still, they should avoid contact with contagious persons. HCWs who are inadvertently exposed to chickenpox should be furloughed, starting from post-exposure day 8 (one is contagious 2 days before the onset of skin lesions) to day 21.^{4,13} This results in the loss of a great number of working days. If HCWs develop lesions suggestive of chickenpox, they should receive oral acyclovir by the first or second day of illness to avoid complicated disease. Also, they should be furloughed until all skin lesions are dry or crusted.¹³

VZ vaccine can be given to children within 3 to 5 days of exposure. This has been shown to be effective in preventing illness or modifying VZ severity.^{1,20} However, this is not recommended in healthcare settings because the optimal protection in adults requires 2 doses. Routine vaccination is, therefore, recommended in all HCWs and is the preferred method in preventing VZ in healthcare settings.¹

Conclusions

All HCWs working in hospitals should be asked for a previous history of chickenpox. Those with a negative history should either be tested for VZ antibody or offered immediate VZ vaccination. Among those who have no history of chickenpox, 26% to 55% will test negative for antibody and require VZ vaccination. Counselling is advocated for those who refuse VZ antibody screening or VZ vaccination in order to avoid nosocomial transmission and complicated disease in adult HCWs.

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