Varicella Zoster Virus infection among Health Care Workers in Taiwan: Seroprevalence and Predictive Value of History of Varicella Infection

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Summary

To prevent nosocomial varicella outbreaks, a varicella program was conducted in a tertiary hospital in Taiwan from 2008 to 2009. This program included antibody testing against varicella zoster virus (VZV), self-administered questionnaire interview to obtain previous history of varicella infection or varicella vaccination, and provision of varicella vaccination to those with seronegativity for VZV. This study analyzed the results of this program, including seroprevalence of VZV and predictive value of self-reported varicella infection or vaccination history among health care workers (HCW) in Taiwan. All HCW (N=3733) in this hospital with a mean age of 34.6 years participated in this program. The seroprevalence of VZV was 91.1%. Sensitivity, specificity, positive, and negative predict value of a self-reported history of varicella infection was 82.3%, 48.6%, 96.3%, and 14.4%, respectively, while that for history of varicella vaccination was 23.4%, 69.4%, 90.9%, and 6.5%, respectively. The recall history of younger age, female, medical professionals (doctors, nurses, and paramedical staff), or HCW at higher risk of exposure to varicella had a higher sensitivity. However, only those of medical professionals had significantly higher PPV. This study concludes a positive recall history of varicella infection and vaccination did not ensure the presence of protective VZV-IgG titer, whereas a negative history

was not predictive of lack of immunity. To effectively prevent nosocomial infection, documenting VZV-IgG titers for all HCW and vaccinating of those who are susceptible is suggested.

Key words: Varicella, Health care worker, Chickenpox, Occupational exposure,

Introduction

Varicella (chickenpox), caused by varicella zoster virus (VZV), is a highly contagious disease that is spread by contact with respiratory droplets and/or vesicle fluid.[1] It is usually self-limited, but may cause severe complications, such as lower respiratory tract infection, skin and soft tissue infection, or even death.[1] In Taiwan, the annual cases of varicella is about 11,000[2] and the estimated varicella-related hospitalization rate was 60 per 1000 patients. Infants and adults aged from 19 to 38 years or older than 75 years have the highest hospitalization rate.[3]

Varicella is a recognized nosocomial infection among health care workers (HCW), who, once infected, may transmit infection to susceptible co-workers and patients under their care.[4] The cost of controlling varicella in the hospital settings can be substantial because identification of cases, furloughing, and serologic testing of susceptible HCW are often indicated after each episode of in-hospital exposure to varicella.[5, 6] Therefore, VZV vaccination has been recommended by the US Centers for Disease Control and Prevention (CDC) for HCW who are susceptible to varicella.[7, 8] In Taiwan, the national recommendations regarding varicella vaccination for susceptible HCW have not been issued. Free VZV vaccination policy is implemented for children older than 1 year since 2004, but not for HCW. To our

knowledge, few hospitals in Taiwan follow the guidelines from US CDC because of the cost related to laboratory testing and providing vaccination. However, several episodes of nosocomial outbreaks of varicella occurred in hospitals in past years.

To expedite control of varicella in the hospital setting, some investigators accepted a past history of varicella infection provided by HCW as a proof of immunity, and serology is used only in cases of unclear or negative history.[1, 6, 9] Nevertheless, it remains a debatable issue to serologically screen selected individuals based on a history of varicella instead of screening all HCW,[10, 11] because the effectiveness of selective program may depend on the prevalence of the disease in the population examined and the reliability of recall history of varicella.

To date, the seroprevalence and reliability of a recall history of varicella among HCW in Taiwan has not been evaluated. The aims of this study were to evaluate the seroprevalence and the reliability of recall history of varicella among HCW in Taiwan which may help guide the development of local screening program to control outbreaks of varicella in the hospital setting.

Methods

Hospital setting

Changhua Christian Hospital (CCH), a 1775-bed tertiary-care hospital providing primary and tertiary care in middle-Taiwan, with an estimated population of 4.48 million.

Study population

All 3733 HCW in the hospital participated in this varicella control program. The types of HCW were grouped into physicians (N=537), nurses (N=1580), paramedical staff (e.g. dietician, pharmacist, rehabilitation staff, laboratory personnel or diagnostic imaging staff) (N=698), and administrative staff (including maintenance, technical, and catering et al.) (N=918). "Risk of exposure" to varicella was regarded as "high" for HCW working in the pediatric department or providing services for varicella (e.g. department of emergency medicine, dermatology or infectious disease)~~infectious diseases~~ according to the definitions of Center for Infection Control at this hospital.

Laboratory investigations and questionnaire interview

Blood tests for VZV antibodies were performed in employees' annual

occupational medical examination from May 2008 to April 2009. Annual medical examination is mandatory for all employees in the hospital. VZV antibody was checked with a commercial enzyme-linked fluorescent immunoassay (ELFA) kit (VIDAS®, bioMerieux, Marcy l'Etoile, France). ELFA is specific for the detection of immunoglobulin G (IgG) antibodies to VZV, with declared sensitivity and specificity of 99.7% and 97.6%, respectively. The patient's immune serum ratio value was classified as positive (≥0.9), negative (<0.60), or equivocal (≥0.6 to <0.90). HCW with either negative or equivocal serum responses were regarded as seronegative, and would be offered with VZV vaccination (Varilrix®, GlaxoSmithKline, or Varivax Refrigerated®, CSL-MSD).

A self-administered questionnaire interview to obtain previous history of varicella infection or vaccination against varicella was performed during health check-up. The answer was yes, no, or unknown. In this study, we retrospectively collected the data using a standardized case record form and analyzed the results of this varicella control program. The study was approved by the Institutional Review Board of CCH.

Statistical analysis

Statistical analysis was performed using SPSS software (version

~~17.0 ,Chicago~~17.0, Chicago, IL, USA). Prevalence of VZV antibody and history of varicella infection or vaccination among different groups (gender, age, type of occupation, or risk of exposure) were calculated. Difference in proportions were assessed by the chi-square test, considering a value of $P<0.05$ as statistically significant. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the recall history for the presence of VZV-IgG were determined. Relative risk (RR) was calculated by logistic regression model. Gender, age, type of occupation and risk of exposure were included in multivariate analysis.

Results

The demographic characteristics of all 3733 HCW are shown in **Table I**. The participants were predominantly female (79.2%) and aged ranging from 18 to 68 years (mean age, 34.6 years); 75.2% were younger than 40 years; 42.3% were nursing staff; and –11.2% of HCW were categorized as the group with high risk of exposure to varicella infection.

The prevalence of VZV seropositivity was 91.1%. The VZV seronegativity group included 200 HCW (5.4%) whose serum samples were reported as seronegative and 133 (3.6%) as sero-equivocal. No significant differences in characteristics were observed between HCW who were VZV seronegative and those who were sero-equivocal other than that HCW who were VZV seronegative were older than those who were sero-equivocal (Table II).

Seropositivity was statistically significantly higher in older HCW than in younger HCW (Table II & Figure 1).

Based on the self-administered questionnaire interview, a previous history of varicella infection was reported by 1465 of the HCW (39.2%), while 354 (9.5%) reported no such a history, and 1914 (51.3%) were unaware of their status. Younger

HCW (aged <50 years), female HCW, medical professionals (doctors, nurses and paramedical staff), and high-risk exposure group were more likely to report a positive history of varicella infection. (Table III & Figure 1)

Of the 1465 HCW who reported a positive history of previous varicella infection, 1411 (96.3%) were seropositive and 54 (3.7%) were seronegative. Among the 354 HCW who reported a negative history of previous varicella infection, 303 (85.6%) were seropositive and 51 (14.4%) were seronegative. A positive recall history of previous varicella infection was significantly associated with a higher prevalence of VZV seropositivity (96.3% Vs 85.6%, *P*<0.001). However, there was no statistically significant difference in terms of seroprevalence between HCW with an uncertain varicella infection history and those with a negative history (88.1% Vs 85.6%, *P*=0.189). In this population, tThe sensitivity of a recall history of previous varicella infection to detect seropositivity for VZV was 82.3% (1411/(1411+303)), whereas the specificity was 48.6% (51/(54+51)). ~~In this population, t~~The PPV ~~of a recall history of varicella infection to predict varicella immunity~~ was 96.3% (1411/1465) and the NPV was 14.4% (51/354). The respective value for sensitivity, specificity, PPV and NPV will be 41.5%, 83.6%, 96.3%, and 12.3%, when people with unknown history of varicella infection were included in the group of participants with a negative history of varicella infection. (Table II)

In multivariate logistic regression analysis (Table IV), the recall history of medical professionals (including doctors, nurses, and paramedical staff) had statistically higher PPV compared with that of administrative staff. Younger age (<50 year), female, medical professionals and high-risk exposure group had significantly higher sensitivity. In contrast, neither NPV nor specificity was significantly influenced by those defined variables. Multivariate logistic regression analysis showed older HCW had a higher seropositivity rate than younger HCW; doctors or nurses had higher seropositivity rates than other co-workers.

Receipt of varicella vaccine was reported by 287 HCW (7.7%), 912 (24.4%) reported a negative vaccination history, and 2534 (67.9%) were unaware of their vaccination history (Table II). Of those 287 HCW with previous varicella vaccination, 261 (90.9%) were seropositive. Subjects with a previous history of varicella vaccination didn't have higher seropositivity to VZV than those without such a vaccination history (90.9% Vs. 91.1%, *P*=0.932). HCW younger than 40 years and doctors were more likely to have received varicella vaccination than other HCW (Figure 1). The sensitivity of VZV vaccination to predict VZV immunity was 23.4% (261/(261+853)) and the specificity was 69.4% (59/(26+59)). PPV was 90.9% (261/287) and NPV was 6.5% (59/912). The figure for sensitivity, specificity, PPV and NPV became 7.7%, 92.2%, 90.9% and 8.9% respectively, when people with

unknown history of vaccination were included in the negative history group.

If recall history of varicella infection and ~~history of~~ vaccination ~~was~~were analyzed together, the sensitivity of positive history to predict VZV immunity was 86.4% (1527/(1527+240)) and the specificity was 36.4% (40/(70+40)). PPV was 95.6% (1527/(1527+70)) and NPV was 14.3% (40/(240+40)). The figure for sensitivity, specificity, PPV and NPV became 44.9%, 79.0%, 95.6% and 12.3% respectively, when people with unknown history were included in the negative history group.

Discussion

To our best knowledge, current study is the first one to document the varicella susceptibility and the reliability of recall history of varicella infection among HCW in Taiwan. In this hospital-wide survey, we have demonstrated that the seropositivity for VZV among HCW was 91.1%. However, only 39.2% of the HCW reported a previous history of varicella infection. The sensitivity, specificity, PPV and NPV of a recall history of varicella infection to predict varicella immunity was 82.3%, 48.6%, 96.3% and 14.4%, respectively. The proportion of HCW who reported having~~had~~ ever received varicella vaccination was low (7.7%), although they are at high risk for varicella infection and work in the hospital with previous episodes of nosocomial varicella outbreaks involving the hospital staff.

It has been suggested that immunity levels of 94% or more are needed to interrupt virus transmission in the health care settings;[12] therefore, the level of VZV seropositivity among HCW in this hospital may not be sufficiently high to prevent further varicella outbreak, and interventions to prevent varicella transmission is desirable, for which varicella vaccination for HCW without immunity may be the most cost-effective strategy.[7, 8] Serological testing for all HCW is the most reliable approach to determinate varicella immunity, but the cost would be significant, though

cost-effectiveness of this approach needs further investigations. The second approach is to rely on a recall history of varicella infection. Several investigators have adopted this approach.[4, 11, 13, 14]

In our study, more than half of HCW (51.3%) were unaware of their previous history of varicella infection; the positive recall history of varicella infection was only 39.2%, which is significantly lower compared with those of other studies, for which the figure ranges from 49.7% to 85.3%.[4, 6, 9, 10, 12, 13] Consequently, our sensitivity (41.5%), which is defined as the ability of a positive history to identify all immune subjects, was lower compared with that of these published studies, which ranges from 50.5% to 59.0%.[4, 10, 12, 13] In our study, younger, female, medical professionals (doctors, nurses, and paramedical staff), or HCW at higher risk of exposure to VZV were more likely to report a history of varicella infection, and therefore, their recall history had a higher sensitivity; however, only the recall history of medical professionals had significantly higher PPV. The possible explanation might be because medical professionals have better knowledge about varicella compared with administrative staff. Our findings suggest that education sessions provided to HCW before questionnaire survey may increase the reliability of a recall history of varicella.

Some studies[4, 11, 13, 14] have found that a positive history of varicella is an

excellent predictor and advocated testing only those individuals with a negative history of varicella infection. This recommendation was based on their high seroprevalence rate (97.7%~98.5%)[4, 11, 13] with PPV might be up to 100%.[4, 11] The seroprevalence (91.1%) and PPV (96.3%) in our study was lower compared with those in these studies, which suggests that a reported history of varicella infection may not ensure the presence of protective VZV-IgG titer. For example, in our study, still 3.7% (54/1465) HCW who reported a positive varicella history remained susceptible to varicella. Screening based on a history of varicella may put these seronegative HCW at risk for nosocomial varicella infection if other measures are not taken. Considering the severity of nosocomial varicella, a documented VZV-IgG titer in all HCW should be considered. Whereas a negative history did not predict lack of immunity (NPV=14.4%), possible reasons might be that most patients got chickenpox when they were younger than 10 years of age (chickenpox peaked in children of 4-5 years),[3] the recall history might be unreliable and underestimated. Accordingly, serological testing rather than presumptive vaccination is advisable to those with a negative or uncertain history of varicella infection.

Studies by Gallagher et al[15] (PPV=95%, NPV=11%) and Almuneef et al[10] (PPV=89%, NPV=22%) also had similar results to ours and recommended serological screening for all HCW involved in patient care and varicella vaccination provided to

those who are susceptible.

Interestingly, HCW with a positive history of varicella vaccination didn't have higher seropositive rate~~.~~, the PPV was not ~~improved~~higher when history of varicella infection and vaccination were analyzed together. These findings suggest that a history of varicella vaccination may not be a reliable indicator of immunity. The possible explanation would be that some~~one~~ of them might not respons~~e~~d to varicella vaccination, the immunity for VZV declines with age, people were not familiar with their vaccination schedules in their childhood or the recall bias.~~or the recall history of vaccination was incorrect.~~

Our study has several limitations and interpretation of our data should be cautious. First, our study involved HCW of only one hospital and the results might not be generalized to all HCW of other hospitals around Taiwan. Nevertheless, this program is the first program to evaluate the varicella susceptibility and reliability of recall history of varicella among HCW in Taiwan, and the study population was large and comprised all HCW with different job titles in a tertiary-care hospital. Our findings may help guide development of a local policy to identify venerable HCW and define recommendation for immunization. The other limitation is that HCW with equivocal serum IgG antibody didn't have their serum levels rechecked to confirm

their immunization status before receiving VZV vaccination. Although this strategy may enhance immunity against varicella for these HCW, some of these HCW who were seroequivocal might demonstrate seropositivity if the serum tests were repeated. Thus, our seropositivity rate may have been underestimated. Finally, we didn't provide education sessions of varicella for HCW before self-administered questionnaire interview and didn't validate their results after collecting the data, ~~better knowledge for varicella~~for which is likely to improve the reliability of recall history.

~~We conclude that seropositive rate of varicella among HCW in this hospital was not sufficiently high to prevent an outbreak, therefore, documenting VZV IgG titers for all HCW and vaccination of those susceptible should be considered to effectively prevent nosocomial varicella. Though a positive recall history of varicella was associated with a significantly higher seropositive rate and might be used as a surrogate of immunity when screening all HCW is not allowed, nevertheless, it will put the seronegative HCW with a positive varicella history at risk for nosocomial varicella infection. The balance between~~

We conclude that seropositive rate of varicella among HCW in this hospital was not sufficiently high to prevent an outbreak. A positive recall history of varicella was

associated with a significantly higher seropositive rate, but did not ensure the presence of protective VZV-IgG titer, whereas a negative history was not predictive of lack of immunity. A history of varicella vaccination had no value as a predictor of susceptibility. The recall history of younger, female, medical professionals, or HCW at higher risk of exposure to varicella had a higher sensitivity; however, only those of medical professionals had significantly higher PPV. To effectively prevent nosocomial varicella, documenting VZV-IgG titers for all HCW and vaccination of those susceptible is suggested. If screening all HCW is impossible and history of varicella would be used as a proof of immunity, efforts to improv~~inge~~ PPV and a pilot study to evaluate the value of PPV are suggested~~is indicated~~. Which level of PPV would tip the balance in favor of simply testing those with a negative or unknown history of varicella needs further cost-benefit analysis.

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Conflict of interest statement

None declared.

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References

1. Holmes CN, Predictive value of a history of varicella infection, *Can Fam Physician* **51**(2005), pp. 60-5.

2. Center for disease control,TAIWAN, Notifiable infectious disease statistics system, Taipei (2010).

3. Lin YH, Huang LM, Chang IS, Tsai FY, Chang LY, Disease burden and epidemiological characteristics of varicella in Taiwan from 2000 to 2005, *J Microbiol Immunol Infect* **42**(2009), pp. 5-12.

4. Chazan B, Colodner R, Teitler N, Chen Y, Raz R, Varicella zoster virus in health care workers in northern Israel: seroprevalence and predictive value of history of varicella infection, *Am J Infect Control* **36**(2008), pp. 436-8.

5. Apisarnthanarak A, Kitphati R, Tawatsupha P, Thongphubeth K, Apisarnthanarak P, Mundy LM, Outbreak of varicella-zoster virus infection among Thai healthcare workers, *Infect Control Hosp Epidemiol* **28**(2007), pp. 430-4.

6. Almuneef M, Dillon J, Abbas MF, Memish Z, Varicella zoster virus immunity in multinational health care workers of a Saudi Arabian hospital, *Am J Infect Control* **31**(2003), pp. 375-81.

7. Lyznicki JM, Bezman RJ, Genel M, Report of the Council on Scientific Affairs, American Medical Association: immunization of healthcare workers with varicella

vaccine, *Infect Control Hosp Epidemiol* **19**(1998), pp. 348-53.

8. Immunization of health-care workers: recommendations of the Advisory Committee on Immunization Practices (ACIP) and the Hospital Infection Control Practices Advisory Committee (HICPAC), *MMWR Recomm Rep* **46**(1997), pp. 1-42.

9. Chong CY, Lim SH, Ng WY, Tee N, Lin RV, Varicella screening and vaccination for healthcare workers at KK Women's and Children's Hospital, *Ann Acad Med Singapore* **33**(2004), pp. 243-7.

10. Almuneef M, Memish ZA, Abbas ME, Balkhy HH, Screening healthcare workers for varicella-zoster virus: can we trust the history?, *Infect Control Hosp Epidemiol* **25**(2004), pp. 595-8.

11. Santos AM, Ono E, Weckx LY, Coutinho AP, de Moraes-Pinto MI, Varicella zoster antibodies in healthcare workers from two neonatal units in Sao Paulo, Brazil--assessment of a staff varicella policy, *J Hosp Infect* **56**(2004), pp. 228-31.

12. De Juanes JR, Gil A, San-Martin M, Gonzalez A, Esteban J, Garcia de Codes A, Seroprevalence of varicella antibodies in healthcare workers and health sciences students. Reliability of self-reported history of varicella, *Vaccine* **23**(2005), pp. 1434-6.

13. Vandersmissen G, Moens G, Vranckx R, de Schryver A, Jacques P, Occupational risk of infection by varicella zoster virus in Belgian healthcare workers: a

seroprevalence study, *Occup Environ Med* **57**(2000), pp. 621-6.

14. Brunell PA, Wood D, Varicella serological status of healthcare workers as a guide to whom to test or immunize, *Infect Control Hosp Epidemiol* **20**(1999), pp. 355-7.

15. Gallagher J, Quaid B, Cryan B, Susceptibility to varicella zoster virus infection in health care workers, *Occup Med (Lond)* **46**(1996), pp. 289-92.

Table I. The baseline characteristics of study population by age groups

	Age(years)	**<30 (%)**	**30-39 (%)**	**40-49 (%)**	**≥50 (%)**	**Total (%)**
		N=1245	**N=1562**	**N=614**	**N=312**	**N=3733**
Gender	Male	137(11.0)	355(22.7)	208(33.9)	77(24.7)	777(20.8)
	Female	1108(89.0)	1207(77.3)	406(66.1)	235(75.3)	2956(79.2)
Occupation	Doctors	106 (8.5)	257(16.5)	129(21.0)	45(14.4)	537(14.4)
	Nurses	790(63.5)	645(41.3)	120(19.5)	25 (8.0)	1580(42.3)
	Paramedical	164(13.2)	314(20.1)	140(22.8)	80(25.6)	698(18.7)
	Administrative	185(14.8)	346(22.1)	225(36.7)	162(52.0)	918(24.6)
Risk of exposure	High	190(15.3)	167(10.7)	45(10.8)	15 (4.8)	417(11.2)
	Normal	1055(84.7)	1395(89.3)	569(17.2)	297(95.2)	3316(88.8)

* Paramedical staff: including dietician, pharmacist, rehabilitation staff, psychologist, laboratory personnel and diagnostic imaging staff.

**Administrative staff: including maintenance, technical, and catering.

Table II. The serum results of varicella antibody (anti-VZV IgG) by different characteristics

		N	Positive (%)		Equivocal		Negative (%)		P-value*
Age (years)	<30	1245	1095	(88.0)	54	(4.3)	96	(7.7)	<.001
	30-39	1562	1435	(91.9)	48	(3.1)	79	(5.1)	
	40-49	614	573	(93.3)	21	(3.4)	20	(3.3)	
	≥50	312	297	(95.2)	10	(3.2)	5	(1.6)	
Gender	Male	777	706	(90.9)	24	(3.1)	47	(6.0)	0.473
	Female	2956	2694	(91.1)	109	(3.7)	153	(5.2)	
Occupation	Doctors	537	502	(93.5)	9	(1.7)	26	(4.8)	0.107
	Nurses	1580	1436	(90.9)	56	(3.5)	88	(5.6)	
	Paramedical	698	640	(91.7)	27	(3.9)	31	(4.4)	
	Administrative	918	822	(89.5)	41	(4.5)	55	(6.0)	
Risk of exposure	High	417	381	(91.4)	18	(4.3)	18	(4.3)	0.427
	Normal	3316	3019	(91.0)	115	(3.5)	182	(5.5)	
History of varicella	Yes	1465	1411	(96.3)	30	(2.0)	24	(1.6)	<.001
	No	354	303	(85.6)	19	(5.4)	32	(9.0)	
	Unknown	1914	1686	(88.1)	84	(4.4)	144	(7.5)	
Receipt of vaccination	Yes	287	261	(90.9)	9	(3.1)	17	(5.9)	0.032
	No	912	853	(93.5)	28	(3.1)	31	(3.4)	
	Unknown	2534	2286	(90.2)	96	(3.8)	152	(6.0)	
History of varicella or vaccination	Yes	1597	1527	(95.6)	35	(2.2)	35	(2.2)	<.001
	No	280	240	(85.7)	16	(5.7)	24	(8.6)	
	Unknown	1856	1633	(88.0)	82	(4.4)	141	(7.6)	
	Total	3733	3400	(91.1)	133	(3.6)	200	(5.4)	

* chi-square test

Table III. The distribution of selective variables in relation to history of varicella infection or receipt of vaccination

		History of varicella						Receipt of vaccination					
		Yes	(%)	No	(%)	Unknown	(%)	P-value*	Yes	(%)	No	(%)	Unknown	(%)	P-value*
Age	<30	511	(41.0)	113	(9.1)	621	(49.9)	<.001	121	(9.7)	209	(16.8)	915	(73.5)	<.001
	30-39	718	(46.0)	129	(8.3)	715	(45.8)		123	(7.9)	456	(29.2)	983	(62.9)	
	40-49	187	(30.5)	61	(9.9)	366	(59.6)		31	(5.0)	177	(28.8)	406	(66.1)	
	≥50	49	(15.7)	51	(16.3)	212	(67.9)		12	(3.8)	70	(22.4)	230	(73.7)	
Gender	Male	269	(34.6)	85	(10.9)	423	(54.4)	0.009	60	(7.7)	186	(23.9)	531	(68.3)	0.937
	Female	1196	(40.5)	269	(9.1)	1491	(50.4)		227	(7.7)	726	(24.6)	2003	(67.8)	
Occupation	Doctors	221	(41.2)	51	(9.5)	265	(49.3)	<.001	50	(9.3)	154	(28.7)	333	(62.0)	0.002
	Nurses	696	(44.1)	131	(8.3)	753	(47.7)		126	(8.0)	398	(25.2)	1056	(66.8)	
	Paramedical	275	(39.4)	62	(8.9)	361	(51.7)		43	(6.2)	173	(24.8)	482	(69.1)	
	Administrative	273	(~~18.6~~29.7)	110	(~~31.1~~12.0)	535	(~~28.0~~58.3)		68	(7.4)	187	(20.4)	663	(72.2)	
Risk of exposure	High	201	(48.2)	29	(7.0)	187	(44.8)		28	(6.7)	138	(33.1)	251	(60.2)	
	Normal	1264	(38.1)	325	(9.8)	1727	(52.1)	<.001	259	(7.8)	774	(23.3)	2283	(68.8)	<.001
Total		1465	(39.2)	354	(9.5)	1914	(51.3)		287	(7.7)	912	(24.4)	2534	(67.9)	

* chi-square test

Table IV. The relative risk (RR) of positive predict value (PPV), negative predict value (NPV), sensitivity and specificity for HCW with positive history of previous Varicella infection by different characteristics

		PPV			NPV			Sensitivity			Specificity		
		%	RR^s	RR^m	%	PR^s	PR^m	%	RR^s	PR^m	%	RR^s	RR^m
Age	<30	96.1	1.00	1.00	20.4	4.09*	2.72	84.5	5.46***	4.40***	53.5	1.70	1.27
	30-39	96.1	1.00	1.03	14.7	2.77	2.18	86.3	6.27***	5.58***	40.4	1.00	1.00
	40-49	97.3	1.48	1.76	9.8	1.75	1.62	76.8	3.31***	3.44***	54.5	1.77	1.40
	≥50	98.0	1.96	2.19	5.9	1.00	1.00	50.5	1.00	1.00	75.0	4.42	5.34
Gender	Male	95.9	1.00	1.00	11.8	1.00	1.28	77.5	1.00	1.00	47.6	1.00	1.16
	Female	96.4	1.14	1.58	15.2	1.35	1.00	83.5	1.47*	1.46	48.8	1.05	1.00
Occupation	Doctors	97.7	3.05*	4.51**	9.8	1.00	1.00	82.4	1.82**	1.92**	50.5	1.64	2.22
	Nurses	96.4	1.90	2.18*	21.4	2.50	2.48	86.7	2.53***	1.71**	52.8	1.83	2.25
	Paramedical	97.8	3.16	3.17*	11.3	1.17	1.42	83.0	1.90**	1.67*	53.8	1.91	2.09
	Administrative	93.4	1.00	1.00	10.0	1.02	1.29	72.0	1.00	1.00	37.9	1.00	1.00
Risk of exposure	High	95.0	1.00	1.00	17.2	1.26	1.07	88.8	1.82**	1.53	33.3	1.00	1.00
	Normal	96.5	1.45	1.78	14.2	1.00	1.00	81.4	1.00	1.00	51.5	2.09	2.29
Total		96.3			14.4			82.3			48.6		

RR^s: RR is calculated by single-variable logistic regression model.

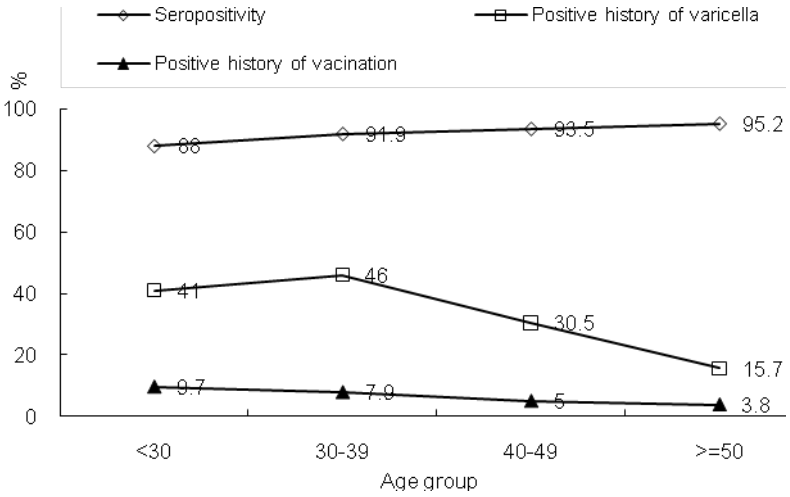
RR^m: RR is calculated by multi-variable logistic regression model, which includes age, gender, occupation and risk of exposure)

* P<0.05, **P<0.01, ***P<0.001

Legend to Figure. The results of seropositivity and positive history of varicella and vaccination history according age group (Figure 1A) and type of work (Figure 1B).

1 Figure 1(A)

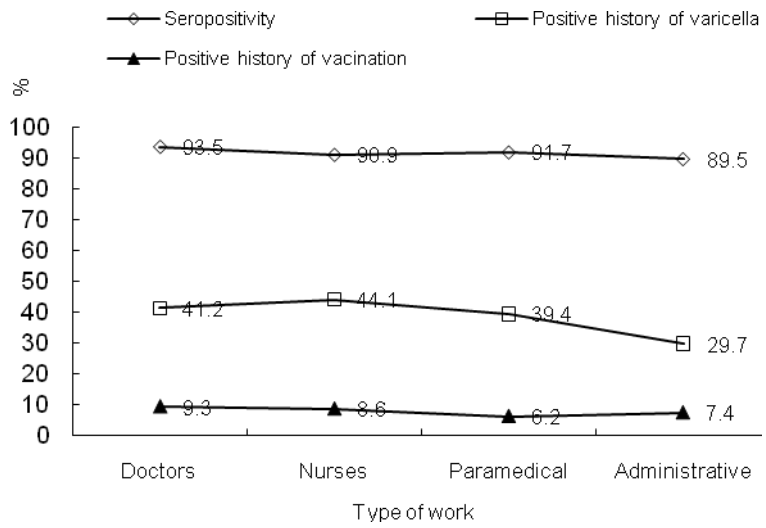
2



3

4

Figure 1(B)


Seropositivity
Positive history of varicella
Positive history of vacination
%
100
90
80
70
60
50
40
30
20
10
0
93.5
90.9
91.7
89.5
41.2
44.1
39.4
29.7
9.3
8.6
6.2
7.4
Doctors
Nurses
Paramedical
Administrative
Type of work