Susceptibility to varicella zoster virus infection in health care workers

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Varicella zoster virus (VZV) is an occupational hazard for a percentage of health care staff. Nine hundred and seventy staff members attending the Occupational Health Department at Cork University Hospital took part in the survey. A latex agglutination assay was used to determine the health care workers immune status to VZV. Of the 970 workers tested, 928 (95.7%) were immune to VZV. The sensitivity, specificity and predictive value of an enquiry regarding a history of chicken-pox was determined on a sample of 206 health care workers. The positive predictive value was 95% (119/125) and the negative predictive value was 11% (4/35). The sensitivity of the enquiry was 79% (119/150), the specificity was 40% (4/10), reducing to 61% (119/195) and 36% (4/11) respectively when individuals with uncertain histories were included in the calculations. The advantages and disadvantages of selective staff screening are discussed. In the authors’ opinion all health care workers involved in the clinical care of patients should be screened by serology for past VZV infection before taking up duty and those who are susceptible to VZV should be made aware of the risks and health effects associated with VZV if contracted.

Key words: Chicken-pox complications; disease transmission; occupational exposure; varicella zoster virus.

INTRODUCTION

Varicella zoster virus (VZV) is a member of the herpes virus group of viruses. VZV is highly contagious being spread from person to person by contact with respiratory secretions and vesicle fluid. Chicken-pox results from primary infection with varicella zoster virus whereas zoster occurs as a result of reactivation of latent virus (shingles).

In the health care setting chicken pox is an occupational hazard for a minority of adults who were not infected in childhood. In some occupational groups the risk is greater; for example in those providing health care for young children.1

Chicken-pox in childhood is usually a mild self limiting illness. Severe cases are more likely to occur in adults. Varicella pneumonia is the most common complication in adults that results in hospitalization. Viral pneumonia occurs in 10–16% of individuals contracting chicken-pox over the age of 19 years.2 The illness is more often fatal in adults.

The purpose of this study was to determine the proportion of health care workers attending an Occupational Health Department who were susceptible to VZV. In addition the sensitivity, specificity and predictive value of a simple enquiry regarding a history of chicken-pox was determined on a sample of the health care workers.

METHODS

Between January 1990 and December 1994, 970 staff members attending the Occupational Health Department at Cork University Hospital who were having venepuncture performed for any reason gave their consent to the analysis of the blood sample for antibodies to VZV. No refusals were recorded. A latex agglutination assay which detects both IgG and IgM class antibodies to VZV (VZVscan, Becton Dickinson) was used to determine the health care workers immune status to VZV. The sensitivity of this test is 100% and specificity 86% when compared to the Diamedix VZV ELISA test. The sensitivity is 97% and specificity 81% when compared to the SAMA fluorescent assay (manufacturers’ figure). The job category of each participant was also documented and the survey group.
were divided into clinical and non-clinical groups depending on job category. Clinical groups included staff categories with routine clinical contact with patients, e.g. clinical medical staff, nursing staff and paramedical staff (e.g. ambulance, physiotherapy, radiographers).

During 1994, 206 participants were also asked the following question: 'have you had chicken-pox or shingles in the past?' The answer could be 'yes', 'no' or 'don't know'.

Given the data recorded and the serological survey the following information was determined for the group as a whole and also for the clinical group alone: (1) the percentage of health care workers immune to VZV; (2) the percentage of health care workers susceptible to VZV.

The results obtained by historical enquiry were compared to those obtained by serology and the sensitivity, specificity, positive and negative predictive values were determined. Sensitivity was defined as the ability of a positive answer on historical enquiry to identify all immune subjects. Specificity was defined as the ability of a negative answer to identify all subjects susceptible to VZV. Positive predictive value is the probability, given a 'yes' answer to the historical enquiry, that the individual will be immune to varicella zoster by serology. Negative predictive value is the probability, given a 'no' answer to the historical enquiry, that the individual will be non-immune to varicella zoster by serology.

RESULTS

Nine hundred and seventy health care workers participated. Of these, 894 were in clinical job categories and 76 were in non-clinical categories. Eighty-eight per cent of the study participants were female of whom 93% were aged less than 40 years at the time of the study.

Of the 970 workers tested, 928 (95.7%) were immune to VZV and 42 (4.3%) were non-immune. Eight hundred and ninety-four clinical staff were tested and of these 854 (95.5%) were immune to VZV and 40 (4.5%) were non-immune.

Of the 206 subjects who were asked whether they had a history of chicken-pox or shingles, 125 (60.7%) answered 'yes'. Thirty-five (17%) answered 'no' and 46 (22.3%) answered 'do not know'. Of the 125 workers who answered 'yes' to the historical enquiry, 119 (95.2%) were immune and six (4.8%) turned out to be non-immune on assay. Of the 35 workers who answered 'no', 31 (88.6%) were immune by assay and only four (11.4%) were non-immune. Of the 46 workers who answered 'don't know' to the historical enquiry, only one was not immune by assay.

The positive predictive value of the historical enquiry was 95% (119/125) while negative predictive value was 11% (4/35). The sensitivity of the historical enquiry to predict immunity by assay was 79% (119/150) and the specificity of the enquiry to predict negative assay (susceptibility) was 40% (4/10). These figures for sensitivity and specificity were reduced to 61% (119/195) and 36% (4/11) respectively when individuals with uncertain histories were included in the calculations (Table 1).

<table>
<thead>
<tr>
<th>VZV assay</th>
<th>History</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Positive</td>
<td>119</td>
<td>57.8</td>
<td>6</td>
<td>2.9</td>
</tr>
<tr>
<td>Negative</td>
<td>31</td>
<td>15.1</td>
<td>4</td>
<td>1.9</td>
</tr>
<tr>
<td>Uncertain</td>
<td>45</td>
<td>21.8</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>195</td>
<td>94.7</td>
<td>11</td>
<td>5.3</td>
</tr>
</tbody>
</table>

A. Individuals with uncertain histories not included in calculations

| Sensitivity | 79% |
| Specificity | 40% |

B. Individuals with uncertain histories are included in calculations

| Sensitivity | 61% |
| Specificity | 36% |

Positive predictive value = 95%; negative predictive value = 11%.

DISCUSSION

Varicella zoster is an occupational hazard for a percentage of health care staff because of its ease of transmission and incidence of complications in adults. In addition cases may be infectious for 1–2 days prior to the eruption of the typical vesicles. The herpes viruses including VZV are also shed in saliva and pose a risk in dental care providers. Seronegative or immuno-compromised providers are at greatest risk.

This study supports others which have demonstrated that among health care workers a proportion remains susceptible to VZV. The proportion of susceptible clinical staff (4.5%) is almost identical to the proportion of susceptible staff overall (4.3%). Other studies have demonstrated similar rates of susceptibility. Ferson et al. surveyed 209 nurses and found a 5% prevalence of susceptibility. McKinney et al. found 2.9% of health care staff to be susceptible to VZV. Persons 35 years old or younger with a clinical history of chicken-pox or zoster were much less likely to be susceptible. Myers et al. found a susceptibility rate of 5.4%. Grimsley et al. found a 4.8% susceptibility rate among day care personnel. Other studies have demonstrated higher rates of susceptibility. Eighteen per cent of a group of 174 female Filipino nurses working at the American University of Beirut Medical Centre were
susceptible to VZV. There is evidence to suggest that adults from the tropics have higher susceptibility.

Murray and Lynch reported a susceptibility rate of 13.5% for first year medical students. The rate for doctors alone in this study was 8.3%. Studies have also been performed to assess for seronegativity among populations with a negative history for VZV infection. This has ranged from 10.6% to 47% among hospital personnel. In the present study the rate was 11.4%.

The discordance between history and assay was confirmed from calculations of sensitivity (79%) and specificity (40%). In other words an enquiry about a history of chicken-pox or shingles identified 79% of health care workers who were immune to VZV, but only 40% of workers who were non-immune. These figures for sensitivity and specificity were reduced to 61% and 36% respectively when individuals with uncertain histories were included in the calculations.

Three different approaches to staff screening for VZV immune status may be adopted: (1) screen all health care workers who will have clinical contact with patients; (2) screen only those who cannot recall a history of VZV infection; (3) screen only those health care workers who work in specific health care areas, e.g. paediatrics, oncology, haematology, maternity, radiotherapy, laboratory, immunology, infectious diseases, or who may be at increased risk because of their own health status, e.g. immune deficiency or pregnancy. There are advantages and disadvantages to each of these approaches.

Screening only those staff who will work in particular areas is an option, but it does not take into account the requirement for staff mobility, often at very short notice, which is an almost universal feature of modern health care.

Screening only those who do not recall a history of VZV on enquiry is another option. In this study 119 out of a total of 125 (95%) who could recall a history of VZV were immune. However an important group are those who give a positive answer to historical enquiry but who are negative on assay because these individuals are at risk but do not realize it. In this study the rate was six out of 125 workers (4.8%). Individuals in this category may believe themselves to be immune and would be less likely to take precautions. They would continue to be exposed to chicken-pox/shingles and therefore increase their risk of contracting VZV.

The main advantage to selective screening of staff is the reduction in cost associated with non-selective testing. Four point three per cent of staff in our study were susceptible. However the test used is not expensive (less than IR£2 per test) and the relative cost of the test decreases as the number of tests performed increases. When the test is performed at the same time as other blood tests there is a decrease in the amount of occupational health staff involvement, and the laboratory analysis can be performed on a routine rather than an urgent basis.

The main disadvantages of selective screening of staff are associated with increased costs associated with VZV infection and control. These costs are incurred from the point of admission of a VZV case and can be substantial. Some of these costs are difficult to quantify. They include urgent use of occupational health, infection control and laboratory time and resources including the cost of patient isolation. It is important not to underestimate the effect on disruption of service and increased staff anxiety. In the event of contact with an infectious case, urgent testing would be required for all those staff members who could not recall a history of VZV, which in our study comprised 81 of the sample of 206 staff (39.3%). Another important group are those who do not know if they have had chicken-pox or shingles, yet are immune on assay [45 out of 46 (98%) in this study]. In the absence of serological testing this group would be regarded as susceptible and in the event of an outbreak could cause serious staffing problems in the short term.

Some of the costs are more readily quantifiable. Redeployment of staff, hiring of temporary staff and temporary suspension of susceptible staff (on pay) who have been in contact with an infectious case can result in considerable extra expense. Basic grade staff nurse pay is about IR£670 for 14 days which would be the approximate cost of 330 VZV assays. VZV specific immunoglobulin if required costs up to IR£1,000 for an adult.

There is also the ever-present threat of litigation and increased insurance premiums as a result of additional cases of VZV resulting from the primary contact, and potential effects on health care workers. Although only 4.3% of health care workers overall and 4.5% of clinical staff were susceptible to VZV in this study, these workers are at risk of primary infection with VZV. Because these workers are adults the risk of complications such as pneumonia would also be higher. Immunologically normal adults who contract VZV have 9–25 times the risk of major morbidity or death from infection compared with healthy children.

VZV infection during pregnancy is associated with a high rate of complications and the risk of the congenital varicella syndrome. Eighty-eight per cent of the study population were female, of whom 93% were less than 40 years of age. The risk of transmission of varicella to the foetus is approximately 24% with a risk of congenital abnormalities of 5% if this occurs in the first trimester of pregnancy. Even if no foetal abnormality results there is an increase in the level of concern and psychological stress which is associated with adverse effects in pregnancy. The cost of a civil claim in these circumstances is likely to be substantial.

Risk assessment and risk management are principal features of current health and safety legislation. Of particular relevance to this study are the regulations concerned with biological agents and pregnant employees. A comprehensive VZV screening program is part of the risk assessment approach. It will allow the pool of susceptible health care workers to be determined and enable appropriate risk management.
procedures to be put in place including clear policies and procedures for patient isolation, staff work restrictions, exposure control and follow-up. In addition if a vaccine becomes available in this country then previously identified susceptible staff members could be considered for vaccination.

CONCLUSION

All health care workers involved in the clinical care of patients should be screened by serology for past VZV infection. This is performed by means of a simple blood test and immunity to rubella and hepatitis B may be checked at the same time. All health care workers susceptible to VZV should be made aware of the risks and health effects associated with VZV if contracted. Consideration should also be given to deploying susceptible staff members away from high risk areas such as work with immune-compromised patients. If a vaccine becomes available in this country then susceptible staff members could be considered for vaccination.

In the event of exposure to VZV, employees with a documented positive assay can continue to work. Those with a negative titre are susceptible and should avoid patient contact from day 8 to day 21 following exposure. High risk susceptible contacts should be considered for varicella zoster immune globulin. If the VZV immune status of all health care workers in clinical contact with patients is known then immediate reallocation is possible which may avoid the need for temporary suspension from duties, urgent serological testing, disruption of service, and increased staff concern. This should result in considerable cost savings as well as a reduction in the risk of civil claims occurring following primary VZV infection in adult health care workers who are susceptible.

REFERENCES