



Major article

Clinical and economic impact of various strategies for varicella immunity screening and vaccination of health care personnel



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Key Words:

Varicella
Occupational health
Screening
Immunization
Occupational exposure
Model

Background: Exposure to patients with varicella or herpes zoster causes considerable disruption to a health care facility's operations and has a significant health and economic impact. However, practices related to screening for immunity and immunization of health care personnel (HCP) for varicella vary widely.

Methods: A decision tree model was built to evaluate the cost-effectiveness of 8 different strategies of screening and vaccinating HCP for varicella. The outcomes are presented as probability of acquiring varicella, economic impact of varicella per employee per year, and cost to prevent additional cases of varicella. Monte Carlo simulations and 1-way sensitivity analyses were performed to address the uncertainties inherent to the model. Alternative epidemiologic and technologic scenarios were also analyzed.

Results: Performing a clinical screening followed by serologic testing of HCP with negative history diminished the cost impact of varicella by >99% compared with not having a program. Vaccinating HCP with negative screen cost approximately \$50,000 per case of varicella prevented at the current level of U.S. population immunity, but was projected to be cost-saving at 92% or lower immunity prevalence. Improving vaccine acceptance rates and using highly sensitive assays also optimize cost-effectiveness.

Conclusion: Strategies relying on screening and vaccinating HCP for varicella on employment were shown to be cost-effective for health care facilities and are consistent with current national guidelines for varicella prevention.

Published by Elsevier Inc. on behalf of the Association for Professionals in Infection Control and Epidemiology, Inc.

Varicella is a highly contagious, vaccine-preventable disease caused by the varicella-zoster virus (VZV). Primary VZV infection

confers lifelong immunity; however, the virus remains dormant in the dorsal root ganglia and may reactivate years later causing herpes zoster (HZ). The implementation of universal immunization against varicella in children has made varicella an uncommon disease in the United States.¹ However, HZ may occur in up to 30% of the adult population, who had their primary infection in the pre-immunization era.^{2,3}

Because of close contact with VZV-infected patients, health care personnel (HCP) are at high risk of being exposed to VZV and may become infected if they are not immune. Exposure of HCP to VZV causes significant disruption to the facility's operations, which is costly to the health care facility and may impact patient care.⁴ Exposure to VZV in health care facilities may also result in nosocomial outbreaks with resulting illness among patients or HCP.^{5,6}

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Funding/Support: Funding in the form of salary support for the authors was provided by the U.S. Department of Veterans Affairs and the Centers for Disease Control and Prevention.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official positions of the Centers for Disease Control and Prevention, the U.S. Department of Human and Health Services, the U.S. Department of Veterans Affairs, or the VA National Center for Occupational Health and Infection Control.

Conflicts of interest: None to report.

Table 1
Strategy definitions for the prevention of varicella infection in health care personnel

Abbreviation	Description
NP	No intervention program. There is no documentation of varicella immune status.
H	Clinical screening only. Clinical screening may include self-reported or physician-confirmed history of varicella or HZ infection, documentation of vaccination, or serologic evidence of immunity that was not obtained at the facility (ie, HCP bringing their records). The information is obtained and recorded. No further testing or vaccination is offered. Immune status is documented as positive or negative-unknown.
HV	Clinical screening and selective vaccination. Clinical data is obtained and recorded. Those with negative or unknown history are offered vaccination. Those with a positive history and those immunized are recorded as positive. Those who refuse vaccination are negative.
S	Serologic screening only. A varicella antibody determination is done as part of the pre-employment testing panel on all HCP. Result is documented as positive or negative.
HS	Clinical screening and selective serologic screening. Clinical data are obtained and recorded. Those with negative or unknown history have a varicella antibody determination done. Those with a positive history and those with a positive serology are recorded as positive. Those with negative serology are negative.
HSV	Clinical screening and selective serologic screening and selective vaccination. Clinical data are obtained and recorded. Those with negative or unknown history have a varicella antibody determination done. Those with negative serologic tests are offered immunization. Those with a positive history, those with a positive serology, and those immunized are recorded as positive. Those who refuse vaccination are negative.
SV	Serologic testing and selective vaccination. A varicella antibody determination is done as part of the pre-employment testing panel on all HCP. Those with a negative serologic tests are offered vaccination. Those with a positive serology and those immunized are recorded as positive. Those who refuse vaccination are negative.
V	Universal vaccination. Every employee is offered varicella vaccination. There is no prior clinical or serologic screening. Those who are immunized are recorded as positive. Those who refuse vaccination are negative.

HCP, health care personnel; HZ, herpes zoster.

The U.S. Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices (ACIP) recommends that all HCP have evidence of varicella immunity.⁷ There is, however, little information on the optimal strategy to achieve this goal and on the influence of different factors on the selection of the preferred strategy. In fact, occupational health (OH) policies pertaining to varicella prevention vary widely across health care facilities.⁸

We evaluate the cost-effectiveness of 8 potential varicella screening for immunity and vaccination strategies for HCP from the economic perspective of the health care facility. In addition, this study establishes a framework to compare potential health care policies and practices with consideration to appropriate clinical, administrative, and economic outcomes relevant to the health care facility.

METHODS

Study design

A cost-effectiveness analysis was conducted by comparing the health benefits and cost of 8 different strategies to screen and immunize HCP against varicella (Table 1).

A decision tree model was developed using TreeAge Pro 2012 (TreeAge Software, Williamstown, MA) (Fig 1), where each primary branch represents a strategy. The model incorporates all essential clinical, epidemiologic, and operational variables. Each variable has a base-case value representing the most likely scenario and a range with a triangular probability distribution (Table 2). The model assumes that each strategy is implemented upon the HCP's employment and their immune status is documented in the employee medical record.

Disease and screening parameters

Risk of exposure and infection

Nationwide Veterans Health Administration (VHA) 2011 administrative data were used to estimate the probability of exposure to VZV. During 2011, VHA provided care to 194 patients with varicella, provided care to 38,451 patients with HZ, and had 277,296 employees (Veterans Health Administration, unpublished data, 2012). The analysis was conducted using HZ exposure only, and the numbers were rounded to the nearest 10,000. It was assumed that every patient with HZ would result in the exposure of

2 to 3 HCP—we used a base case of 2.5—and that HZ is one-fifth as contagious as varicella.⁹

Clinical screening

Clinical screening encompasses assessing immunity to varicella by self-reported history of varicella or HZ, documentation of vaccination, or serologic evidence of immunity. However, for the model we calculated sensitivity and specificity of clinical screening based on data from self-reported history of varicella considering a positive predictive value (PPV) of 99% and a negative predictive value (NPV) of 15%,¹⁰ at a prevalence of varicella immunity of 97%.¹¹

Serologic testing

The performance characteristics for serologic assays were obtained by calculating the average sensitivity and specificity of 16 commercial VZV IgG assays.¹²

Cost parameters

Costs were considered from the perspective of the health care facility. We included costs from the OH intervention (eg, time spent by the OH provider, laboratory, and vaccine acquisition costs) and costs associated with the disruption caused by the response to VZV exposures in the facility (Table 2). All costs are in 2012 U.S. dollars.

Costs of screening

The model assumes that screening occurs in the context of a comprehensive pre-employment health evaluation. The cost of screening for varicella history included the OH provider's time to inquire, assess, and document evidence of immunity by history or document previous vaccination or serology not obtained at the facility.

It was assumed that health care facilities send their varicella serologic testing to reference laboratories. The cost of serologic testing includes, in addition to the maximum 2012 allowable Medicare charge by laboratories for the test,¹³ the OH provider's time to enter the order, review, and document the results; the phlebotomist's time and supplies; and the laboratory personnel's time for shipping the sample and routing the test results.

Vaccination-associated cost included cost of the vaccine^{14,15} and costs related to consultation, ordering, administration, documentation, and supplies.

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