
Strategies for the Control and Investigation of Varicella Outbreaks 2008

Adriana S Lopez, MHS and Mona Marin, MD

**National Center for Immunization and Respiratory Diseases
Centers for Disease Control and Prevention**

Summary

Following implementation of the one-dose varicella vaccination program in the United States in 1995, varicella vaccination coverage has steadily increased and the number of varicella cases has decreased. However, despite the increasing use of varicella vaccine, outbreaks of varicella have continued to occur, even in settings with high vaccination coverage. Thus, in June 2006, a second dose of varicella vaccine was added to the routine childhood vaccination program to assist, in part, with outbreak prevention and control.

To improve existing knowledge about the epidemiology of varicella and to have a basis for refining varicella vaccination policy, it is important to monitor and investigate varicella outbreaks. These guidelines for the control and investigation of such outbreaks were developed by the Centers for Disease Control and Prevention's (CDC's) National Center for Immunization and Respiratory Diseases (NCIRD) with input from state and local public health departments. Public health officials should implement appropriate responses to reports of varicella cases to determine if an outbreak exists and, if so, to evaluate its scope and implement control measures appropriate to the outbreak setting.

Table of Contents

I. Introduction	5
II. Background	6
III. Reporting	7
IV. Case Definition and Classifications	7
V. Laboratory Diagnosis of Varicella	8
VI. Definitions	9
VII. Recommendations	10
A. A Single Varicella Case as a Potential Source for an Outbreak	12
B. Confirm the Outbreak	12
C. Identify Cases	12
D. Implement Varicella Control Measures	12
D.1. Notification of Outbreak	12
D.2. Exclusion or Isolation of Case-Patients	13
D.2.a. Management of herpes zoster case-patients as potential sources for varicella outbreaks	13
D.2.b. Isolation precautions	13
D.3. Management of Persons without Evidence of Immunity	14
D.3.a. Identification of persons without evidence of immunity	14
D.3.b. Vaccination of persons without evidence of immunity	14
D.3.c. Management of persons who refuse vaccination	15
D.3.d. Management of persons with contraindications to the varicella vaccine	15
D.3.e. Management of persons with rash developing within 42 days after vaccination	15
E. Conduct Case Investigation	16
E.1. Information to Obtain from Persons with Varicella	16
F. Establish Surveillance for Additional Cases	17
F.1. Components of Varicella Surveillance in an Outbreak Setting	17
G. Analyze and Interpret the Data	17
G.1. Interpretation of the Data	17
H. Develop a Plan for Preventing Future Varicella Outbreaks	18
VIII. Vaccine	19
IX. Conclusion	19
X. References	20

XI. Appendix A: Sample varicella outbreak reporting worksheet	24
XII. Appendix B: Sample exposure letters	25
XIII. Appendix C: Sample survey to identify cases of varicella in setting	26
XIV. Appendix D: Sample letters of notification of varicella outbreak	28
XV. Appendix E: Sample varicella case investigation form	30
XVI. Appendix F: Useful formulas for investigations of varicella outbreaks	35
XVII. Appendix G: Sample varicella surveillance worksheet	36

I. INTRODUCTION

Before licensure of the varicella vaccine, varicella was a common childhood disease, causing about 4 million cases, including an average of 10,500 hospitalizations and 105 deaths, each year [1–3]. The varicella vaccine was licensed for use in the United States in 1995 and was recommended by the Advisory Committee on Immunization Practices (ACIP) and the American Academy of Pediatrics (AAP) for routine use in healthy children 12–18 months of age and for older susceptible children and adults [4, 5]. In 2006, national 1-dose varicella vaccination coverage among children 19–35 months of age was 89% [6] and varicella-related morbidity and mortality had declined significantly following implementation of the 1-dose varicella vaccination program. The incidence of disease decreased 90% between 1995 and 2005, with the greatest decline in children and adolescents [7]. National varicella hospitalizations declined 88% during 1994–2002 [8], and age-adjusted mortality rates decreased 66% from 1990–1994 to 1999–2001, with the greatest decline (92%) in children 1–4 years of age [3].

Recommendations for the prevention of varicella were updated in 2006 to include a routine two-dose schedule for children; the first dose is recommended at 12–15 months of age and the second dose at 4–6 years of age, with catch-up vaccination for all persons without evidence of immunity to varicella and for one-dose vaccine recipients [9]. One of the rationales for the second-dose recommendation was to reduce the number of varicella outbreaks because of the burden they caused on public health personnel, schools, and families. Therefore, tracking outbreaks through existing case-based surveillance will help states and CDC monitor the impact of this new recommendation.

As overall disease incidence declines, the risk for exposure to varicella-zoster virus (VZV) decreases, leading to susceptible (unvaccinated and vaccinated) children aging into adolescence and adulthood. Although the total number of varicella cases is declining, a shift of the remaining varicella disease burden to middle school years is being observed. In 1995, the median age of varicella infection ranged from 3–5 years in vaccinated persons and from 5–6 years in unvaccinated persons. By 2005, the median age increased to 6–8 years in vaccinated persons and 13–19 years in unvaccinated persons [7].

As the age of infection increases, varicella outbreaks may occur more frequently in middle schools, high schools, and colleges. Implementation of recommended catch-up vaccination for older children and adolescents and varicella vaccination requirements for day care, elementary, middle, and high school, and college entry will prevent increasing susceptibility and subsequent outbreaks in these age groups [9]. Achieving high immunization levels in day care centers, schools, and colleges is important because transmission of infectious diseases like varicella is facilitated by the increased contact rates among students [10]. In the United States, school requirements have proven to be an extremely effective strategy for achieving high vaccination coverage among school-aged children [11]. As of September 2007, 48 states and the District of Columbia had implemented requirements that children entering day care or school must have received either one dose of varicella vaccine or have other evidence of immunity to varicella. Twenty-six states have requirements for entry to middle or high school [CDC unpublished data, 12]. States are in the process of transitioning to the two-dose varicella vaccination school entry requirements for elementary schools; the number of states with college entry requirements is not known.

Investigations of varicella outbreaks in schools and other settings in the vaccine era will improve our knowledge of the epidemiology of varicella, assess virus transmission patterns, describe disease burden and risk factors for severe varicella, provide estimates of varicella

vaccine effectiveness for two versus one dose of vaccine, and identify risk factors for vaccine failure. In addition, monitoring the number and size of varicella outbreaks will help to assess impact of the second-dose recommendation. These data will facilitate the development and refinement of appropriate public health interventions to control and prevent future varicella outbreaks and further reduce varicella morbidity and mortality.

II. BACKGROUND

Varicella (chickenpox) is the disease that results from primary infection with the varicella-zoster virus (VZV). It is a highly contagious rash illness that is transmitted from person to person by direct contact with patients with either varicella or herpes zoster (HZ) or by airborne spread (from respiratory secretions or aerosolized vesicular fluid from skin lesions). Secondary attack rates among susceptible household contacts occur in 65% to 86% of cases [13-15]. The average incubation period is 14–16 days (range, 10–21 days). Persons with varicella are considered infectious from 1 to 2 days before the rash appears and until all lesions are crusted over (average range, 4–7 days after rash onset). Infants, adolescents, adults, and immunocompromised persons are at higher risk for complications. Persons with underlying immunocompromising medical conditions (e.g., cancer, HIV/AIDS) are especially likely to have more severe disease and a longer time to crusting of lesions; thus, they may shed virus from skin lesions for a prolonged period [16]. Severe complications of varicella include secondary bacterial infections, dehydration, pneumonia, encephalitis, and cerebellar ataxia, all of which may result in death.

Varicella in vaccinated persons (i.e., breakthrough disease) is a varicella-like rash that occurs more than 42 days after vaccination. The disease is usually mild with a shorter duration of illness, less constitutional symptoms, and fewer than 50 skin lesions (sometimes even <10; compared with approximately 250–500 lesions in unvaccinated healthy persons). Rash is atypical, often maculopapular, with few or no vesicles. However, breakthrough varicella disease in vaccinated persons has been shown to be contagious. Seward et al. [15] demonstrated that vaccinated persons with <50 lesions were one-third as contagious as unvaccinated persons, but vaccinated persons with ≥ 50 lesions were just as contagious as unvaccinated persons. Varicella outbreaks have been documented in highly vaccinated populations [17-20] and vaccinated case-patients acted as index cases in several outbreaks. Although breakthrough varicella is generally mild, approximately 25% of case-patients may have >50 lesions and clinical features similar to those among unvaccinated persons. However, serious complications have been reported among persons who developed <50 lesions [21].

Pre- and post-licensure studies have demonstrated vaccine effectiveness of one dose of the varicella vaccine to be about 80–85%, on average, for prevention of disease of any severity and >95% for prevention of severe disease [17-19, 22-35]. In a clinical trial comparing one versus two doses of varicella vaccine, for disease of any severity, the risk for developing breakthrough varicella was >3-fold lower among two-dose vaccinees compared with one-dose vaccinees [32]. Vaccine efficacy of two doses was significantly higher compared with that of one dose (98% vs 94%; $p < 0.001$) [32]. Studies are needed to assess the field effectiveness of two doses; however, on the basis of results from the clinical trial, it is expected to be higher than the effectiveness of one dose.

After primary infection as varicella, VZV resides in the cell bodies associated with spinal nerves. Reactivation of latent VZV results in HZ (shingles). Clinical features of HZ include a

localized pruritic, often painful, vesicular rash that generally appears unilaterally in one or more dermatomes [36]. Persons with HZ are infectious during the vesicular stages of rash; the rash typically crusts over within 7–10 days but may take from 2 to 6 weeks to heal completely [36,37]. Immunocompromised persons are at increased risk of disseminated or more severe disease. Localized HZ is approximately one-fifth as infectious as varicella or disseminated HZ [38], but transmission of VZV has been reported. Reports indicated the rare occurrence of airborne transmission of VZV from HZ case-patients in healthcare settings [39-41]. HZ case-patients have also been identified as the index case in outbreaks of varicella [42].

III. REPORTING

At the beginning of the varicella vaccination program in 1995, active surveillance sites were established to assist with monitoring. However, to fully assess the impact of the varicella vaccination program, national surveillance is needed.

As a first step in establishing national varicella surveillance, varicella deaths became nationally notifiable in 1999 [43]. In 2002, the Council of State and Territorial Epidemiologists (CSTE) recommended that states begin reporting individual cases of varicella by 2003 and implement state-wide case-based reporting by 2005 [44]. The three initial core variables recommended by CDC for case-based reporting included age, vaccination status, and severity of disease (based on number of lesions). However, states conducting case-based surveillance should now be collecting standard demographic, clinical, and epidemiologic data on each case. States unable to collect these data should collect, at a minimum, the three key variables mentioned above. It is also important to collect information on the case outcome (i.e., whether the patient was hospitalized or died). Probable and confirmed cases of varicella should be reported to CDC. In 2007, 34 states reported varicella cases to the National Notifiable Diseases Surveillance System (NNDSS). To report varicella-specific data, a varicella messaging guide has been created to inform states on how to develop a message to extract the varicella variables from their surveillance system and send to CDC. The guide is available in CDC's [Varicella Notification Message Mapping Guide](#) . State and local health departments rely on healthcare providers, public health workers, and school nurses to report varicella cases and related deaths. For information on the specific varicella reporting requirements for a particular state, contact the local or state health department.

Tracking the number and size of varicella outbreaks through existing varicella case-based surveillance is another varicella surveillance strategy that can be used to monitor the impact of the two-dose recommendation. For states that have not yet established varicella case-based reporting, tracking only the number and size of varicella outbreaks may be a feasible alternative until case-based reporting is established. Reporting of varicella outbreaks can be facilitated in states with mandatory reporting of outbreaks of all reportable diseases in the state. Nineteen states are currently conducting varicella outbreak surveillance which includes collecting case-based data on cases associated with varicella outbreaks. A sample worksheet for monitoring varicella outbreaks is available in Appendix A.

IV. CASE DEFINITION AND CLASSIFICATION

The following case definitions were approved by CSTE for varicella disease in 1999 and for varicella-related deaths in 1998 [43,45].

Varicella clinical case definition. An illness with acute onset of diffuse (generalized) maculopapulovesicular rash without other apparent cause. In vaccinated persons who develop varicella more than 42 days after vaccination (i.e., breakthrough disease), the rash may be atypical in appearance (maculopapular with few or no vesicles).

Varicella case classification.

- **Probable.** A case that meets the clinical case definition, is not laboratory confirmed, and is not epidemiologically linked to another probable or confirmed case.
- **Confirmed.** A case that is laboratory confirmed or a case that meets the clinical case definition and is epidemiologically linked to a confirmed or a probable case. *Note:* Two probable cases that are epidemiologically linked are considered confirmed, even in the absence of laboratory confirmation.

Varicella deaths classification.

- **Probable.** A probable case of varicella that contributes directly or indirectly to acute medical complications that result in death.
- **Confirmed.** A confirmed case of varicella that contributes directly or indirectly to acute medical complications that result in death.

Laboratory Criteria for Diagnosis

- Direct detection—the demonstration of VZV antigen by polymerase chain reaction (PCR) tests, by direct fluorescent antibody (DFA), or by isolation of VZV through viral culture from a clinical specimen. These viral detection methods are the laboratory methods of choice for confirmation of varicella disease.
- Four-fold or greater rise in serum varicella immunoglobulin G (IgG) antibody level between acute and convalescent serum by a quantitative serologic assay. A four-fold rise in IgG antibodies might not occur in vaccinated persons [46].
- Serologic test results that are positive for varicella-zoster immunoglobulin M (IgM) antibody by IgM capture assay. However, there is not much experience with IgM antibody testing and the IgM response in unvaccinated persons. Even less information is available for vaccinated persons.

V. LABORATORY DIAGNOSIS OF VARICELLA

The mild or atypical presentation of breakthrough varicella coupled with the rarity of cases in unvaccinated persons (due to the continued decline of varicella incidence in the vaccination era) creates challenges for clinical diagnosis and emphasizes a need for laboratory confirmation of cases. It is important for healthcare providers to consider varicella as a possible diagnosis for case-patients who have atypical presentation (e.g., <50 lesions that are mainly macular) because suspicion of varicella disease (e.g., link to case in school) is needed before laboratory diagnosis is considered. All state public health laboratories now have the capacity to diagnose VZV disease by PCR.

Genotyping of VZV is also important for certain situations. In addition, it helps with the understanding of transmission of endemic disease. Genotyping will identify the strain as vaccine or wild-type and will provide details for further characterization of the virus. Specimens for confirmation and genotyping can be sent to the [National VZV Laboratory](#); this website includes a link to the VZV Specimen Collection Form, which must be included with each sample that is sent, and it includes a video demonstrating the techniques for collecting different specimens for varicella confirmation. Additional information about laboratory testing for varicella diagnosis,

including virus identification and isolation, serologic testing, and specimen collection, can be found in the Varicella chapter of the [Vaccine Preventable Diseases Surveillance Manual](#).

VI. DEFINITIONS

- **Airborne transmission.** Dissemination of airborne VZV-containing droplet nuclei or particles in the respirable size range that remain infective over time and distance. VZV carried in this manner may be dispersed by air currents and may be inhaled by susceptible persons who have not had face-to-face contact with or been in the same room with an infectious person [47].
- **Direct contact transmission.** Transfer of VZV from one infected person to another person without a contaminated intermediate object or person [47].
- **Droplet transmission.** Also considered a form of contact transmission. Conjunctival, nasal, or oral mucosa contact with VZV-containing droplets (size $>5\mu\text{m}$) generated from an infected person (by coughing, sneezing, and talking or during certain medical procedures, such as suctioning or bronchoscopy) and propelled a short distance (e.g., ≤ 3 feet) [47].
- **Exposure.** Close contact with an infectious person, such as close indoor contact (e.g., in the same room) or face-to-face contact. Experts differ in their opinion about the duration of contact; some suggest 5 minutes and others up to 1 hour, but do agree that it does not include transitory contact [48].
- **Evidence of immunity to varicella [9] includes**
 - **Documentation of age-appropriate vaccination**
 - Preschool-aged children aged ≥ 12 months: 1 dose
 - School-aged children, adolescents, and adults: 2 doses (for children who received their first dose at age < 13 years and for whom the interval between the 2 doses was ≥ 28 days, the second dose is considered valid)
 - **Laboratory evidence of immunity**
 - Laboratory confirmation of disease.
 - Serologic confirmation of immunity. Commercial assays (IgG) can be used to assess disease-induced immunity, but they lack sensitivity to always detect vaccine-induced immunity (i.e., they might yield false-negative results).
 - **Birth in the United States before 1980.** For healthcare personnel, pregnant women, and immunocompromised persons, birth before 1980 should not be considered evidence of immunity; in such cases, the other criteria of evidence of immunity should be sought.
 - **Diagnosis or verification of a history of varicella disease by a healthcare provider.** For typical disease, diagnosis or verification of history of disease can be provided by any healthcare provider (e.g., school or occupational clinic nurse, nurse practitioner, physician assistant, or physician). For persons reporting a history of, or reporting with, atypical or mild cases, assessment by a physician or their designee is recommended, and one of the following should be sought: 1) an epidemiologic link to a typical varicella case or laboratory-confirmed case or 2) evidence of laboratory confirmation (if laboratory testing was performed at the time of acute disease). When such documentation is lacking, persons should not

be considered as having a valid history of disease because other diseases can mimic mild atypical varicella.

- **Diagnosis or verification of a history of herpes zoster by a healthcare provider.**
- **High risk person/contact.** Someone at increased risk for complications from varicella disease because of their age or an underlying condition (e.g., immunocompromised persons, cancer patients, pregnant women, neonates whose mothers are not immune).
- **Incubation period.** The period between exposure to VZV and onset of rash. The average incubation period for varicella is 14–16 days, with a range of 10–21 days.
- **Index case.** The first person with varicella identified in a chain of transmission.
- **Infectious period.** The period during which an infected person sheds VZV, beginning 2 days before rash onset until all lesions are crusted over or until no new lesions appear within a 24-hour period (average range, 4-7 days).
- **Outbreak.** The occurrence of ≥ 5 varicella cases that are related in place and epidemiologically linked.
- **Residential institution settings.** May include settings like long-term care facilities, nursing homes, and group homes.
- **School settings.** May include child care centers, elementary, middle, and/or high schools, or colleges/universities.

VII. RECOMMENDATIONS

As varicella outbreaks continue to occur in the United States, states will need to prioritize investigations of outbreaks. State or local health departments should decide on the level of action required. Box 1 lists outbreaks that are considered high priority for control and investigation because they present the greatest risk of severe morbidity from varicella or may impact the community. Box 2 outlines strategies for the control and investigation of varicella outbreaks. These strategies are based on experience with varicella outbreaks in the United States and are presented for outbreaks in school, residential institution, and healthcare settings but can be applied to other setting.

Identification of a single case of varicella should trigger appropriate intervention measures as such cases can be sources for potential outbreaks. Different settings may have specific internal guidelines for managing a single case of varicella (e.g., prisons [49]) and these guidelines should be observed to help prevent outbreaks in the particular settings. These present guidelines provide an overall approach to the control and investigation of varicella outbreaks among children in school settings and among adults in closed settings. Many circumstances surrounding outbreaks will vary and require modified approaches to meet practical limitations of the outbreak site.

Box 1: Varicella outbreaks for priority control and investigation by public health authorities

1. Outbreaks involving patients and staff in healthcare settings.
2. Outbreaks involving patients with complications (e.g., pneumonia, encephalitis, invasive Group A streptococcal infection, or hemorrhagic complications) and/or hospitalizations (≥ 1 case).
3. Outbreaks involving persons at risk for severe varicella because of their age or an underlying condition (e.g., immunocompromised persons, cancer patients, pregnant women, neonates whose mothers are not immune).
4. Outbreaks involving cases among persons vaccinated with two doses of varicella vaccine.

Box 2. Steps for the control and investigation of outbreaks of varicella

- A. A single varicella case as a potential source for an outbreak
- B. Confirm the outbreak
- C. Identify cases
- D. Implement varicella control measures
 1. Notification of the outbreak
 2. Exclusion or isolation of case-patients
 3. Management of persons without evidence of immunity
- E. Conduct case investigations
- F. Establish surveillance for additional cases
- G. Analyze and interpret the data
- H. Develop a plan for preventing future varicella outbreaks

A. A Single Varicella Case as a Potential Source for an Outbreak

The identification of a single case of varicella should trigger intervention measures because this case could lead to an outbreak. The first step is to exclude or isolate the case from the setting (e.g., school) immediately. Next, a notification letter can be sent to those that may have been exposed to the case (e.g., in a school setting, the letter could be sent home with the children in the same classroom as the case). However, how broadly to distribute the notification letter for a single case will be up to the discretion of the health department or setting. The notification letter should alert the person to the possibility of exposure to varicella, describe the disease, recommend vaccination if the person is not already considered immune, and recommend exclusion if disease develops. Examples of exposure letters are available in Appendix B.

B. Confirm the Outbreak

The first step in the control and investigation of a suspected varicella outbreak is to confirm that it is an outbreak. Physicians and public health professionals should make every effort to establish epidemiologic links for cases and obtain clinical specimens for laboratory testing. During an outbreak, laboratory confirmation of varicella is recommended for at least three to five cases (irrespective of the patients' vaccination status), especially at the beginning of the outbreak. Laboratory confirmation of cases at the end of the outbreak is helpful to document the end of the outbreak.

C. Identify Cases

Once an outbreak of varicella is confirmed, the affected population should be surveyed to identify all cases. Case finding is an important step for outbreak control and can be done concurrently with implementing control measures. Key information that should be collected from case-patients includes age, vaccination status, disease history, and underlying medical conditions. For outbreaks that are fully investigated, the same information should also be collected from persons without varicella. An example of a survey is available in Appendix C.

D. Implement Varicella Control Measures

Implementing outbreak control measures requires various activities, including notification of the outbreak, exclusion or isolation of varicella case-patients and, if appropriate, HZ case-patients, and management of persons without evidence of immunity.

D.1 Notification of the Outbreak

Notification of an outbreak of varicella and increasing awareness in the affected setting or community is an important step for controlling the outbreak. For outbreaks in school settings, all parents of children attending day care centers or schools where an outbreak occurs should be sent a letter that notifies them about the outbreak and provides recommendations on intervention measures (e.g., vaccination, exclusion). In the letter, parents of children without evidence of varicella immunity should be advised to have their child vaccinated with the appropriate dose or, if vaccination is contraindicated or refused, exclude the child from school up to 21 days after the last case is identified. During an outbreak, a second dose of varicella vaccine is also recommended for children 1–4 years of age to assist with outbreak control. Parents should contact their regular healthcare provider or local health department to vaccinate their child or any other household member who needs vaccination. Active identification of persons with immunocompromising conditions who do not have evidence of immunity to varicella is also

recommended so that appropriate control measures can be implemented (e.g., exclude up to 21 days after the last identified case, provide varicella-zoster immune globulin [VZIG] if indicated). Examples of letters notifying parents of a varicella outbreak in a school are available in Appendix D.

Local or state health departments should be notified by schools or healthcare providers when cases of varicella are identified. Other healthcare providers in the community should also be notified of the outbreak by the local or state health departments through a health alert, asked to report varicella case-patients they consult with in the office or by phone, and collect clinical specimens to confirm the disease. Notification of varicella outbreaks is also needed for residential institution and healthcare settings because of the higher risk for severe disease in the populations they serve. Residents, staff, patients, and the local or state health department should be notified of outbreaks in such settings.

As part of the notification, a fact sheet with information about the signs and symptoms of varicella, complications from the disease, and basic facts about the vaccine can be provided to both parents and healthcare providers. A fact sheet about varicella disease is available at CDC's [Vaccines and Preventable Diseases: Varicella \(Chickenpox\) Vaccination](#) Website, and the varicella vaccine information statement is available at [Chickenpox Vaccine: What You Need to Know](#) .

D.2 Exclusion or Isolation of Case-patients

Depending on the setting, isolation of persons with active disease consists of excluding, furloughing, or grouping together (cohorting) persons who are ill and are likely to transmit varicella until their rash has crusted over. Vaccinated persons with varicella may develop lesions that do not crust (macules and papules only). Isolation guidance for these persons is to exclude until no new lesions appear within a 24-hour period.

D.2.a Management of herpes zoster case-patients as potential sources for varicella outbreaks

School settings. Immunocompetent persons with HZ can remain at school as long as the lesions can be completely covered. Persons with HZ should be careful about personal hygiene, wash their hands after touching their lesions and also avoid close contact with others. If the lesions cannot be completely covered and close contact avoided, children and staff should be excluded from the school setting until lesions have crusted over. If a person has disseminated HZ, he or she should be excluded from school until lesions have crusted over (similar to the management of varicella case-patients).

Residential institution and healthcare settings. For immunocompetent residents or patients with localized HZ, lesions should be completely covered and contact precautions should be followed. For immunocompromised persons with HZ or persons with disseminated HZ, the management is similar to that of varicella case-patients.

For healthcare personnel who develop HZ, lesions should be completely covered with a taped dressing and, in addition to standard contact precautions, the healthcare worker should be removed from direct care of patients at high risk of severe complications from varicella. A healthcare worker with disseminated HZ should be excluded from work until lesions have crusted over [9].

D.2.b Isolation precautions

In residential and healthcare settings, airborne infection isolation (i.e., negative air-flow rooms) and contact precautions should be followed for varicella, disseminated HZ, or localized

HZ in an immunocompromised person; standard precautions should be followed for localized HZ in an immunocompetent person [47]. If negative air-flow rooms are not available, varicella case-patients should be isolated in closed rooms with no contact with persons without evidence of immunity. Isolated case-patients should be cared for by staff with evidence of immunity to varicella (to determine immune status see section *D.3 Management of Persons without Evidence of Immunity*).

D.3 Management of Persons without Evidence of Immunity

D.3.a Identification of persons without evidence of immunity

Identifying persons without evidence of varicella immunity during an outbreak is important for preventing the spread of disease and for protecting those at high risk for severe disease.

Information about a history of varicella disease and vaccination should be collected from all persons in the outbreak setting. Healthcare provider diagnosis or verification of history of disease is needed for valid evidence of immunity. Immunization records, data from an immunization registry, and records obtained by contacting healthcare providers can be used to verify vaccination history.

Birth in the United States before 1980 is considered evidence of immunity in most cases; however, it is not considered as evidence of immunity for healthcare personnel, pregnant women, and immunocompromised persons. Epidemiologic and serologic studies have indicated that >95% of American adults aged ≥ 20 years are immune to varicella [CDC unpublished data, 50]. In addition, 71–93% of adults with no history or an uncertain history of disease will have VZV antibodies when tested [51–55]. Therefore, in healthcare institutions, serologic screening before vaccination of personnel who have no history or an uncertain history of varicella and who are unvaccinated is likely to be cost effective. State health laboratories offer VZV IgG testing.

D.3.b Vaccination of persons without evidence of immunity

Persons without evidence of immunity to varicella and who do not have a contraindication to vaccination should be vaccinated. Studies conducted among children showed that vaccine administered within 3 days of exposure to rash is most effective in preventing disease ($\geq 90\%$); however, vaccine administered within 5 days of exposure to rash is about 70% effective in preventing disease and 100% effective in modifying disease [22,56,57]. In a varicella outbreak setting, ongoing exposures are likely and may continue for weeks and even months [25]. Thus, to limit disease transmission during an outbreak and to provide protection against subsequent exposures, ACIP recommends that all persons without evidence of immunity to varicella be offered vaccine even if more than 5 days have passed since first exposure to the disease [9].

School settings. One dose of the varicella vaccine has been used successfully for outbreak prevention and control in school settings [58]. A second dose is now recommended for outbreak control [9]. Children who are vaccinated with a first or second dose during an outbreak may immediately return to school after vaccination. For outbreaks among preschool-aged children in particular, a second dose of varicella vaccine is recommended to provide optimal protection for children 1–4 years of age [9].

Residential institutions and healthcare settings. These institutions are environments in which transmission of VZV is likely to occur, and residents and staff are at high risk for exposure. Also, risk of severe disease and complications may be higher among persons without evidence of immunity because of age or immune status. Outbreaks in residential institutions can

be reduced or prevented if new residents and staff who do not have evidence of immunity are vaccinated before moving in or beginning their employment at the institution.

If exposure occurs in high-risk settings, such as healthcare and certain residential institutions, persons without evidence of immunity should be offered varicella vaccine within 3–5 days of exposure to varicella rash to provide the greatest protection against developing disease. Unvaccinated healthcare workers and staff without evidence of immunity to varicella who are exposed to varicella should be furloughed from days 8 to 21 after exposure because they are potentially infectious during this period. Postexposure vaccination should be given as soon as possible after exposure but vaccination is still indicated >5 days postexposure because it induces protection against subsequent exposures. Healthcare workers and staff who have previously received one dose of varicella vaccine and have been exposed to varicella should receive the second dose within 3–5 days after exposure to rash if more than 4 weeks have elapsed since receipt of the first dose. After vaccination, management is similar to that of two-dose vaccine recipients. Healthcare workers and staff who have received two doses of varicella vaccine and are exposed to varicella should be monitored daily from day 8 to 21 after exposure through the employee health program or infection control nurse to determine clinical status (screen for fever, skin lesions, and systemic symptoms). Exposed healthcare workers and staff should be instructed to immediately report fever, headache, or other constitutional symptoms and any skin lesions and should be immediately placed on sick leave if any of these symptoms occur [9].

D.3.c Management of persons who refuse vaccination

Children who lack evidence of immunity and whose parents refuse vaccination should be excluded from school from the start of the outbreak through 21 days after rash onset of the last identified case. Exclusion of persons vaccinated with one dose is difficult to enforce unless existing school regulations are in place for a second dose. For example, if a state has a law requiring a second dose of varicella vaccine for entry to grades K-3, during an outbreak the health department can choose to recommend exclusion of children in grades K-3 with one dose who refuse to get vaccinated with the second dose. The second dose can also be recommended for children in grades 4 and above but exclusion of one dose recipients would be difficult to enforce without the school entry law for those grades. The degree of response with regard to exclusion can vary by state and/or jurisdiction.

D.3.d Management of persons with contraindications to the varicella vaccine

Persons without evidence of immunity who have contraindications to vaccination (e.g., immunocompromised persons, pregnant women) should be excluded from an outbreak setting through 21 days after rash onset of the last identified case-patient because of the risk of severe disease in these groups. If these persons are exposed to a case of varicella or HZ, VZIG should be administered as soon as possible and within 96 hours of exposure [59].

D.3.e Management of persons with rash developing within 42 days after vaccination

These persons should be considered as having wild-type VZV unless otherwise demonstrated. Rashes occurring within 42 days of vaccination can be due to either incubating wild-type VZV or the vaccine strain [60]. Transmission of varicella vaccine virus from a healthy person to a susceptible contact is very rare, particularly in the absence of rash in the vaccine recipient. Higher risk for transmission of vaccine virus has been documented among children who have both rash following vaccination and an immunocompromising condition [61]. Transmission has also been documented among children who are immunocompetent but have rash following vaccination [62]. If vaccine-associated rash is suspected, every effort should be made to determine if the rash is due to vaccine virus or wild-type VZV. The National VZV

Laboratory at CDC has the capacity to distinguish between wild-type VZV and the vaccine (Oka/Merck) strain. For further information, contact CDC laboratory staff at 404-639-0066 or 404-639-3667 or email vzvlab@cdc.gov. A [Specimen Collection Form](#) must accompany specimens submitted to the National VZV Laboratory.

If rash following vaccination occurs in a healthcare worker or contact of an immunocompromised person, contact with persons without evidence of immunity who are at risk for severe disease and complications should be avoided until all lesions have crusted over or no new lesions appear within a 24-hour period.

E. Conduct Case Investigations

After finding all cases and implementing control measures, the next step would be to collect information about the case-patients to characterize the illness and outbreak.

E.1 Information To Obtain from Persons with Varicella (A sample of a case investigation form is available in Appendix E)

- Name, address, and telephone number(s) to reach the person after the initial interview, if necessary.
- Demographic information, including country of birth.
- Clinical details, including the following:
 - Date of rash onset, duration, and severity of rash. Severity can be measured by the number of skin lesions (e.g., < 50 [can be counted in 30 seconds], 50–249, 250–499, and ≥500 [confluence of lesions in many skin areas]).
 - Presence of other symptoms (e.g., fever).
 - Complications and/or hospitalizations and death.
 - Treatment, if any (e.g., acyclovir).
 - History of varicella disease.
 - Pre-existing long-term medical conditions (e.g., asthma, cystic fibrosis, cancer, HIV/AIDS).
 - Medications (e.g., immunosuppressive drugs, aspirin).
- Vaccination status, including the following:
 - Number of doses.
 - Date(s) of varicella vaccination.
 - Provider names and contact information.
 - If not vaccinated, describe reason.
- Source of infection, including the following:
 - Contact with a probable or confirmed case or a person with a rash illness suspected of being varicella or HZ and date of exposure.
 - Transmission setting (e.g., home, day care center, school, institution).
- Laboratory information, if clinical specimens are collected, including
 - Date and source (e.g., crusts, vesicular fluid) of specimen for viral isolation, PCR, and/or DFA.
 - Results of PCR, DFA, or viral isolation (positive or negative for VZV).
 - Serologic test dates and results.

If the source of infection is HZ, information about the HZ case-patient should also be collected (e.g., onset date of HZ case-patient, age, site of lesions and evolution, underlying

medical conditions, contact with varicella case-patients). In residential institution settings, such as correctional or training facilities, medical records of case-patients are likely to be available and should be used as additional sources of information on illness, treatment during illness, pre-existing conditions, and prior medications.

F. Establish Surveillance for Additional Case-patients

Concomitantly with implementing control measures (i.e., exclusion of case-patients, vaccination of persons without evidence of immunity) and collecting data related to the outbreak, active surveillance to identify additional case-patients should be established. Cases should be considered part of an outbreak if they occur within at least one incubation period (21 days) of the previous case-patient, and surveillance should continue through two full incubation periods (42 days) after the rash onset of the last identified case-patient to ensure that the outbreak has ended.

F.1 Components of Varicella Surveillance in an Outbreak Setting

- Reporting should be encouraged from healthcare providers, day cares, schools, colleges, and other settings as appropriate, where varicella cases might occur.
 - Establish regular reporting mechanisms (e.g., daily or weekly) using standard varicella case investigation forms with hospitals, physicians' offices, clinics, and/or schools to obtain reports of persons with rash illness suspected of being varicella.
- Distribute guidelines instructing healthcare providers to obtain appropriate clinical specimens for laboratory diagnosis (example available at the CDC [National VZV Laboratory](#) website).

G. Analyze and Interpret the Data

Data analyses should be aimed at understanding why the outbreak occurred and at providing guidance for control and prevention of future outbreaks. For outbreaks of varicella that are investigated, detailed information (e.g., demographics, underlying medical conditions, vaccination information) should be collected from both case-patients and persons without varicella. As cases of varicella are identified, an epidemic curve illustrating the number of cases by date of rash onset will provide a useful picture of the outbreak. Analyses of the data may consist of calculations of varicella vaccination coverage rates based on the number of doses (if applicable), attack rates by age and other variables of interest (e.g., vaccination status, grade), descriptions of the pattern of disease transmission, severity of disease, and the occurrence of complications [17,19,34,35,63]. Data should be analyzed throughout the investigation. Vaccine effectiveness can also be calculated to determine how well the vaccine is preventing varicella in a specific population [see Appendix F for formulas]. For outbreaks involving adolescents or adults, describing the impact of the outbreak, including the costs incurred for missed work or training, case-patient treatment, and outbreak control, might also be useful for the investigation.

G.1 Interpretation of the Data

A high proportion of unvaccinated case-patients is suggestive of low vaccination coverage as a cause of the outbreak; a high proportion of vaccinated case-patients is suggestive of vaccine failure as a cause of the outbreak. Higher attack rates in one group versus another group (e.g., different grades in a school) could suggest different intensities of exposure or differences in vaccine coverage. Understanding interactions between case-patients and persons without varicella is important for determining risk of exposure. For example, if second and third

graders were the only grades in a school that had cases of varicella and they have little to no interaction with the other grades in the school, it might be most appropriate to concentrate on these two grades for the analysis.

Vaccine effectiveness calculations from outbreak investigations should be interpreted carefully. Vaccine effectiveness calculations should focus on vaccinated and unvaccinated persons with comparable exposures so that vaccine effectiveness will not be under- or overestimated. The varicella vaccine does not provide 100% protection; it is expected that cases will occur among vaccinated persons, although disease is generally milder than that in unvaccinated persons.

The following risk factors have been identified in various outbreak investigations and studies for one dose, but findings are not consistent: age at vaccination, time since vaccination, history of asthma, eczema, or steroid treatment, and < 28 day interval between varicella and MMR vaccine [19,25,29,31,34,64]. It is difficult to control for the effect of multiple risk factors (e.g., age at vaccination and time since vaccination or asthma/eczema and steroid treatment) in outbreak investigations because of the small number of case-patients.

None of the varicella outbreak investigations to date have identified vaccine source, storage, or handling as a risk factor for vaccine failure. However, deficiencies in storage and handling practices could also result in low vaccine effectiveness in the field. Varicella vaccine, either as Varivax or ProQuad (MMRV), has specific storage and administration requirements (must be stored at $\leq -15^{\circ}\text{C}$ and used within 30 minutes of reconstitution), which could affect the effectiveness of the vaccine under field conditions [9,65]. The source of the vaccine and determination of whether clustering of cases by provider or clinic has occurred, should be examined.

H. Develop a plan for preventing future varicella outbreaks

Future varicella outbreaks can be prevented by ensuring high levels of varicella immunity, vaccinating persons without evidence of immunity, establishing and maintaining varicella surveillance and reporting, and preparing an appropriate response when a case of varicella is identified in a particular setting.

- High levels of varicella immunity can be ensured by
 - Implementing day care, school, and college entry requirements to increase vaccination coverage among children, adolescents, and young adults.
 - Requiring varicella evidence of immunity in healthcare workers.
 - Vaccinating residents of residential institutions who do not have evidence of immunity or contraindications to vaccination.
 - Vaccinating healthcare, residential institution, and school staff who do not have evidence of immunity (or a contraindication to vaccination) before or shortly after beginning their employment.
- Management of single case-patients includes
 - Confirming the diagnosis.
 - Exclusion or isolation of the case-patient.
 - Notification to contacts of possible exposure to varicella case-patient.
 - Identifying contacts without evidence of immunity and providing appropriate prophylaxis as indicated.
 - Conducting surveillance for additional case-patients.

- Establishing and maintaining varicella surveillance will ensure that varicella cases are identified in a timely manner so that control measures can be implemented for preventing further transmission. The recommendation by CSTE to begin case-based reporting of varicella cases as of 2005 will help improve the timely identification of outbreaks of varicella. As of September 2007, 35 states report conducting varicella case-based surveillance. An example of a varicella surveillance worksheet is available in Appendix G.

VIII. VACCINE

For detailed information about varicella vaccination and recommendations for use, see [“Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices \(ACIP\)”](#)

Reporting of Adverse Events

The National Vaccine Injury Act of 1986 requires that all physicians and other healthcare providers who administer vaccines maintain permanent immunization records and report occurrences of adverse events for selected vaccines. Serious adverse events (i.e., all events requiring medical attention) should be reported to VAERS. Forms and instructions are available at <https://secure.vaers.org/vaersDataEntryintro.htm>, in the FDA Drug Bulletin at <http://www.fda.gov/medwatch>, or by calling (800) 822-7967.

IX. CONCLUSION

The control and investigation of outbreaks of varicella are important for preventing further spread of varicella disease. Strategies for controlling varicella outbreaks include confirming the outbreak, identifying cases, implementing varicella control measures, conducting case investigations, and establishing surveillance for additional cases. Achieving and maintaining high varicella vaccination coverage rates in preschool children with one dose and in school and college populations and healthcare workers with two doses will be important to prevent varicella outbreaks. Varicella case-based surveillance, including detection of varicella outbreaks, is important for documenting the impact of the two-dose varicella vaccination policy and changes to varicella epidemiology. Case-based surveillance with collection of additional details of source cases, including laboratory confirmation and viral genotyping, will increasingly be needed to characterize endemic disease transmission. Investigations of varicella outbreaks will also help to (1) understand why outbreaks continue to occur, (2) develop and refine appropriate public health interventions to control varicella outbreaks and prevent future outbreaks, and (3) provide the basis for refinements to the varicella vaccination policy.

X. REFERENCES

1. Wharton M. The epidemiology of varicella-zoster virus infections. *Infect Dis Clin North Am.* 1996;10:571-81.
2. Galil K, Brown C, Lin F, Seward J. Hospitalizations for varicella in the United States, 1988 to 1994. *Pediatr Infect Dis J.* 2002;21:931-4.
3. Nguyen HQ, Jumaan AO, Seward JF. Decline in mortality due to varicella after implementation of varicella vaccination in the United States. *N Engl J Med.* 2005;352:450-8.
4. CDC. Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 1996;45(RR-11).
5. Committee on Infectious Diseases, American Academy of Pediatrics. Recommendations for the use of live attenuated varicella vaccine. *Pediatrics* 1995;95:791-6.
6. CDC. National, state, and urban area vaccination coverage among children aged 19-35 months – United States, 2006. *MMWR* 2007;56:880-5.
7. Guris D, Jumaan AO, Mascola L, et al. Changing varicella epidemiology in active surveillance sites - United States, 1995-2005. *J Infect Dis.* 2008;197(Suppl 2):S71-5.
8. Zhou F, Harpaz R, Jumaan AO, Winston CA, Shefer A. Impact of varicella vaccination on health care utilization. *JAMA.* 2005;294:797-802.
9. CDC. Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 2007;56(RR-4).
10. Orenstein WA, Hinman AR. The immunization system in the United States - the role of school immunization laws. *Vaccine.* 1999;17 Suppl 3:S19-24.
11. Kolasa MS, Klemperer-Johnson S, Papania MJ. Progress toward implementation of a second-dose measles immunization requirement for all schoolchildren in the United States. *J Infect Dis* 2004;189(Suppl 1):S98-S103.
12. Lopez AS, Kolasa MS, Seward JF. Status of varicella vaccination school entry requirements and vaccination coverage eleven years after implementation of the varicella vaccination program. *J Infect Dis.* 2008;197(Suppl 2):S76-81.
13. Hope-Simpson RE. Infectiousness of communicable diseases in the household (measles, chickenpox, and mumps). *Lancet.* 1952;263:549-54.
14. Ross AH. Modification of chicken pox in family contacts by administration of gamma globulin. *N Engl J Med.* 1962;267:369-76.
15. Seward JF, Zhang JX, Maupin TJ, Mascola L, Jumaan AO. Contagiousness of varicella in vaccinated cases: a household contact study. *JAMA.* 2004;292:704-8.
16. Balfour HH. Varicella zoster virus infections in immunocompromised hosts. A review of the natural history and management. *Am J Med* 1988;85:68-73.
17. Lopez AS, Guris D, Zimmerman L, et al. One dose of varicella vaccine does not prevent school outbreaks: is it time for a second dose? *Pediatrics.* 2006;117:e1070-7.
18. CDC. Outbreak of varicella among vaccinated children--Michigan, 2003. *MMWR Morb Mortal Wkly Rep.* 2004;53:389-92.
19. Tugwell BD, Lee LE, Gillette H, Lorber EM, Hedberg K, Cieslak PR. Chickenpox outbreak in a highly vaccinated school population. *Pediatrics* 2004;113:455-59.
20. Parker AA, Reynolds MA, Leung J, et al. Challenges to implementing second dose varicella vaccination during an outbreak in the absence of a routine two-dose vaccination requirement— Maine, 2006. *J infect Dis.* 2008;197(Suppl 2);S101-7.

21. Chaves SS, Zhang J, Civen R, et al. Varicella disease in vaccinated persons: clinical and epidemiologic characteristics, 1997-2005. *J Infect Dis.* 2008;197(Suppl 2):S127-31.
22. Arbeter AM, Starr SE, Plotkin SA. Varicella vaccine studies in healthy children and adults. *Pediatrics* 1986;78(suppl):748-56.
23. White CJ, Kuter BJ, Hildebrand CS, et al. Varicella vaccine (VARIVAX) in healthy children and adolescents: results from clinical trials, 1987 to 1989. *Pediatrics.* 1991;87:604-10.
24. Krause PR, Klinman DM. Efficacy, immunogenicity, safety, and use of live attenuated chickenpox vaccine. *J Pediatr.* 1995;127:518-25.
25. Izurieta HS, Strebel PM, Blake PA. Postlicensure study of varicella vaccine during an outbreak in a child care center. *JAMA* 1997;278:1495-9.
26. Buchholz U, Moolenaar R, Peterson C, Mascola L. Varicella outbreaks after vaccine licensure: should they make you chicken? *Pediatrics* 1999;104(3 Pt 1):561-3.
27. Clements DA, Moreira SP, Coplan PM, Bland CL, Walter EB. Postlicensure study of varicella vaccine effectiveness in a day-care setting. *Pediatr Infect Dis J* 1999;18:1047-50.
28. Vazquez M, LaRussa PS, Gershon AA, Steinberg SP, Freudigman K, Shapiro ED. The effectiveness of the varicella vaccine in clinical practice. *N Engl J Med* 2001;344:955-60.
29. Dworkin MS, Jennings CE, Roth-Thomas J, Lang JE, Stukenberg C, Lumpkin JR. An outbreak of varicella among children attending preschool and elementary school in Illinois. *Clin Infect Dis* 2002;35:102-4.
30. Galil K, Fair E, Mountcastle N, Britz P, Seward J. Younger age at vaccination may increase risk of varicella vaccine failure. *J Infect Dis* 2002;186:102-5.
31. Vazquez M, LaRussa PS, Gershon AA, et al. Effectiveness over time of varicella vaccine. *JAMA* 2004;291:851-55.
32. Kuter B, Matthews H, Shinefield H, et al. Ten year follow-up of healthy children who received one or two injections of varicella vaccine. *Pediatr Infect Dis J.* 2004;23:132-37.
33. Marin M, Nguyen HO, Keen J, et al. Importance of catch-up vaccination: experience from a varicella outbreak, Maine, 2002-2003. *Pediatrics.* 2005;115:900-5.
34. Galil K, Lee B, Strine T, et al. Outbreak of varicella at a day-care center despite vaccination. *N Engl J Med* 2002;347:1909-15.
35. Lee BR, Feaver SL, Miller CA, Hedberg CW, Ehresmann KR. An elementary school outbreak of varicella attributed to vaccine failure: policy implications. *J Infect Dis.* 2004;190:477-83.
36. Arvin AM. Varicella-zoster virus. *Clin Microbiol Rev.* 1996;9:361-81.
37. Schmader K. Herpes zoster in older adults. *Clin Infect Dis.* 2001;15:1481-86.
38. Seiler HE. A study of herpes zoster particularly in relation to chickenpox. *J Hyg* 1949;47:253--62.
39. Josephson A, Gombert ME. Airborne transmission of nosocomial varicella from localized zoster. *J Infect Dis.* 1988;158:238-41.
40. Asano Y, Iwayama S, Miyata T, et al. Spread of varicella in hospitalized children having no direct contact with an indicator zoster case and its prevention by a live vaccine. *Biken J.* 1980;23:157-61.
41. Hyams PJ, Stuewe MC, Heitzer V. Herpes zoster causing varicella (chickenpox) in hospital employees: cost of a casual attitude. *Am J Infect Control.* 1984;12:2-5.
42. Lopez AS, Burnett-Hartman A, Nambiar R, et al. Transmission of a newly characterized strain of the varicella-zoster virus from a herpes zoster patient in a long term care facility, West Virginia, 2004. *J Infect Dis.* 2008;197:646-53.

43. Council of State and Territorial Epidemiologists (CSTE). 1999 Position Statements. CSTE Annual Meeting, Madison, WI. Position Statements ID-9. 1999. Available at: <http://www.cste.org/dnn/AnnualConference/PositionStatementTemplates/PositionStatements/tabid/191/Default.aspx>.
44. Council of State and Territorial Epidemiologists (CSTE). 2002 Position Statements. CSTE Annual Meeting, Kansas City, Missouri. Position Statement ID-6. Available at: <http://www.cste.org/dnn/AnnualConference/PositionStatementTemplates/PositionStatements/tabid/191/Default.aspx>.
45. Council of State and Territorial Epidemiologists (CSTE). 1998 Position Statements. CSTE Annual Meeting, Des Moines, Iowa. Position Statement ID-10. 1998. Available at: <http://www.cste.org/dnn/AnnualConference/PositionStatementTemplates/PositionStatements/tabid/191/Default.aspx>.
46. Weinmann S, Chun C, Mullooly JP, et al. Laboratory diagnosis and characteristics of breakthrough varicella in children. *J Infect Dis*. 2008;197(Suppl 2):S132-8.
47. Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings, June 2007, Available at: <http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Isolation2007.pdf>.
48. American Academy of Pediatrics. Varicella-zoster infections. In: Pickering LK, ed. Red book: 2006 report of the Committee on Infectious Diseases. 27th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2006:711-25.
49. Federal Bureau of Prisons. Clinical practice guidelines: management of varicella zoster virus infections. October 2002. Available at: <http://www.bop.gov/news/PDFs/varicella.pdf>.
50. Kilgore PE, Kruszon-Moran D, Seward JF, et al. Varicella in Americans from NHANES III: implications for control through routine immunization. *J Med Virol* 2003;70:S111-8.
51. Alter SJ, Hammond JA, McVey CJ, Meyers MG. Susceptibility to varicella-zoster virus among adults at high risk for exposure. *Infect Control* 1986;7:448-51.
52. Kelley PW, Petruccioli BP, Stehr-Green P, Erickson RL, Mason CJ. The susceptibility of young adult Americans to vaccine-preventable infections: a national serosurvey of US Army recruits. *JAMA* 1991;266:2724-9.
53. Ferson MJ, Bell SM, Robertson PW. Determination and importance of varicella immune status of nursing staff in a children's hospital. *J Hosp Infect* 1990;15:347-51.
54. Struewing JF, Hyams KC, Tueller JE, Gray GC. The risk of measles, mumps, and varicella among young adults: a serosurvey of US Navy and Marine Corps recruits. *Am J Public Health* 1993;83:1717-20.
55. McKinney WP, Horowitz MM, Battiola RJ. Susceptibility of hospital-based health care personnel to varicella-zoster virus infections. *Am J Infect Control* 1989;17:26-30.
56. Asano Y, Nakayama H, Yazaki T, Kato R, Hirose S. Protection against varicella in family contacts by immediate inoculation with live varicella vaccine. *Pediatrics* 1977;59:3-7.
57. Salzman MB, Garcia C. Postexposure varicella vaccination in siblings of children with active varicella. *Pediatr Infect Dis J* 1998;17:256-7.
58. Hall S, Galil K, Watson B, et al. The use of school-base vaccination clinics to control varicella outbreaks in two schools. *Pediatrics* 2000;105:e17.
59. CDC. A new product (VariZIG™) for postexposure prophylaxis of varicella available under an investigational new drug application expanded access protocol. *MMWR Morb Mortal Wkly Rep*. 2006;55:209-10.

60. Sharrar RG, LaRussa P, Galea SA, et al. The postmarketing safety profile of varicella vaccine. *Vaccine*. 2001;19:916-23.
61. Tsolia M, Gershon AA, Steinberg SP, Gelb L. Live attenuated varicella vaccine: evidence that the virus is attenuated and the importance of skin lesions in transmission of varicella-zoster virus. National Institute of Allergy and Infectious Diseases Varicella Vaccine Collaborative Study Group. *J Pediatr*. 1990;116:184-89.
62. Grossberg R, Harpaz R, Rubtcova E, Loparev V, Seward JF, Schmid DS. Secondary transmission of varicella vaccine virus in a chronic care facility for children. *J Pediatr*. 2006 Jun;148:842-4.
63. Haddad MB, Hill MB, Pavia AT, et al. Vaccine effectiveness during a varicella outbreak among schoolchildren: Utah, 2002-2003. *Pediatrics*. 2005;115:1488-93.
64. Verstraeten T, Jumaan AO, Mullooly JP, et al. A retrospective cohort study of the association of varicella vaccine failure with asthma, steroid use, age at vaccination, and measles-mumps-rubella vaccination. *Pediatrics* 2003;112:e98-e103.
65. CDC. Notice to readers: licensure of a combined live attenuated measles, mumps, rubella, and varicella vaccine. *MMWR Morb Mortal Wkly Rep*. 2005;54:1212-14.

XI. Appendix A: Sample varicella outbreak reporting worksheet

Varicella Outbreak Reporting Worksheet

Date of Report to CDC: ___/___/___

State reporting	Name of Person Reporting	Phone	Email	Fax

Please enter the total number of reported outbreaks for the calendar year in this box → Year of report: _____

If more detailed information about each individual outbreak is available, please enter the information in the table below.

Outbreak	Dates of outbreak	Outbreak setting (e.g., day care, elementary, middle, high school, etc)	Size of outbreak (total # of cases)	Number of cases in each age group				Number of cases in each lesion category		Vaccination status of cases			Vaccination coverage in setting		Number of laboratory confirmed cases in outbreak
										# vax		# unvax	1-dose	2-dose	
										1-dose	2-dose				
1				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									
2				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									
3				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									
4				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									
5				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									
6				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									
7				<1	15-19	<50									
				1-4	≥20	50-249									
				5-9	Unk	250-499									
				10-14		≥500									

Please email or fax this form annually to Adriana Lopez at CDC: alopez@cdc.gov or 404-639-8665

****PLEASE NOTE: Minimum information requested for reporting is total number of outbreaks per year****

XII. Appendix B: Sample exposure letters developed by the Connecticut Department of Public Health

A. [Sample varicella exposure letter](#)

B. Sample DRAFT herpes zoster exposure letter

To: Parent or Guardian
From: Director, Daycare X
Subject: Shingles Exposure at Daycare
Date: Any Date

Dear Parent or Guardian:

This letter is to notify you that a case of shingles has been reported at Daycare X and that your child may have been exposed.

Shingles is a form of chickenpox (also known as varicella). In about 15-20% of persons who get chickenpox, the virus will remain in their body in a part of a nerve near the spinal cord. As a person becomes older, the virus may become active again and cause a local, painful rash along the path of that nerve. This rash is known as shingles.

Because shingles results from an earlier chickenpox infection becoming active again within the person, shingles is not spread from one person to another. However, because the same virus causes shingles and chickenpox, persons with shingles can spread the chickenpox virus. In persons with shingles, the virus is usually transmitted by contact with fluid from the rash. Those persons who have had chickenpox or have received the chickenpox (varicella) vaccine are protected against infection from exposure to shingles.

Those persons who have not had chickenpox or have not received the chickenpox (varicella) vaccine are susceptible to infection from exposure to shingles. Susceptible persons develop chickenpox rather than shingles. Though chickenpox is usually a mild disease, it can be more severe in older persons.

Daycare X and the Connecticut Department of Health recommend that susceptible individuals contact their regular health care provider to seriously consider getting vaccinated now. Vaccination against chickenpox greatly reduces both the mild and serious risks of chickenpox and future shingles and can also stop the spread of the chickenpox virus to others who are susceptible.

A copy of an informational handout from the Connecticut Department of Public Health is included to help answer any questions you may have about chicken pox, shingles, and the chickenpox (varicella) vaccine.

For additional information, please call your health care provider.

Sincerely,

XIII. Appendix C: Sample survey to identify cases of varicella in setting

Please complete this survey and have your child return it to his or her teacher by **(insert date)**. All information will be kept strictly confidential. Your participation is completely voluntary; if you do not want to answer any or all questions you don't have to.

ID Number: _____
(for office use only)

Parents/Guardians with more than one child in school should fill out a separate survey for each child

Survey for Parents/Guardians of Children

1. Name of person completing this form: _____
2. Relationship to child: Parent Other (please specify): _____
3. Child's Name: _____
Child's Address: _____
_____ Zip code _____
Parents' Telephone: () _____
4. Child's date of birth: ____/____/____
Month Day Year
5. Child's age: _____ years
6. Sex of child: Male Female
7. Child's Race/Ethnicity: (Check one)
 African-American Asian/ Pacific Islander Native American/Alaskan Hispanic
 White (Caucasian) Other (please write): _____
8. **Child's school (insert name of school):** _____
9. When did your child **first start attending** this school? ____/____
Month Year
10. What **grade** is your child in this year? _____ What is the name of his/her **teacher**? _____
11. Who is your child's primary care **physician**?
Physician: _____
Address: _____
Telephone: () _____
12. Has your child received **immunizations at other location(s)** other than his/her primary care provider office listed above in question 11? Yes No
12a. **If YES**, where did your child receive immunizations? (If more than one location, please provide all names)
Name of facility: _____
Address: _____
Telephone: () _____
13. Do you have an immunization record (shot card) available for your child? (Note-Please do not attach shot card)
 Yes No

Please Check Your Immunization Record (Shot Card) to Answer the Next Section.

If you do not have a shot card, please fill in as much as you remember.

14. Has your child ever received the chickenpox vaccine before the current outbreak? (*There are 2 licensed vaccines for varicella: [1]VARIVAX, which became available in 1995 and [2]PROQUAD, which became available in 2005*)
 Yes If yes, number of vaccine doses: 1 dose 2 doses
Vaccination Date **Dose 1**: ____/____/____ Vaccine name: Varivax Proquad Unknown
Month Day Year
Provider name : _____ Phone number: () _____
Provider address: _____
Vaccination Date **Dose 2**: ____/____/____ Vaccine name: Varivax Proquad Unknown
Month Day Year
Provider name: _____ Phone number: () _____
Provider address: _____
 No Please specify why your child has not ever received the chickenpox vaccine before the current outbreak. **(check all that apply)**
 My child already had chickenpox disease.
 I have philosophical or religious beliefs that do not support childhood vaccination against disease.
 My child's doctor/health care provider never offered the chickenpox vaccine for my child.
 My child has a medical contraindication such that s/he cannot receive the chickenpox vaccine.
 Other (please specify): _____
 Don't know

(SURVEY CONTINUES ON BACK)

15. Does your child have any of the following long-standing health conditions?

- asthma eczema cancer (specify: _____) other (specify: _____)
- none don't know

15a. Does your child currently take any **medications** prescribed by a physician for this condition?

- Yes, please list medication names: _____
- No

16. Has your child had **chickenpox** disease since the start of this outbreak (insert date)? Yes No Don't know

16b. **Who diagnosed** the case of chickenpox? (Check one)

- Primary care provider or clinic listed in question 11 or 12a (Please circle which one)
- Other physician or clinic, please specify _____
- Parents/friends/ relatives
- School nurse
- Other, please specify _____

17. Has your child ever had **chickenpox** disease prior to this outbreak (insert date)? Yes No Don't know

17a. **If YES**, at what **age**? _____ Years OR _____ Months

17b. **Who diagnosed** the case of chickenpox? (Check one)

- Primary care provider or clinic listed in question 11 or 12a (Please circle which one)
- Other physician or clinic, please specify _____
- Parents/friends/ relatives
- School nurse
- Other, please specify _____

18. Other than the chickenpox mentioned above, did your child have any rashes, insect bites, bumps, spots, or blisters at any time after the **start of this outbreak (insert date)**? Yes No Don't know

19. How can we contact you if further information is needed?

Phone Number: () _____

Best time to call: _____

20. We would like to verify your child's vaccination history either from records kept at school or your child's health care provider (or vaccine provider, if different). All information will be kept strictly confidential and will be identified only by number in our files. I agree to allow verification of my child's vaccination history I do not agree

Signature of parent/caregiver

Printed name of parent/caregiver

THANK YOU FOR COMPLETING THIS SURVEY!

XIV. Appendix D: Sample letters of notification of varicella outbreaks

A. [Sample varicella outbreak notification letter](#) available from the Connecticut Department of Public Health

B. Example 2 of varicella outbreak notification letter:

Dear parents/guardians,

This letter is to notify you that some children attending _____ (*insert name of school*) have contracted chickenpox. Varicella causes an acute illness with a rash that results in children missing days at school while they have a rash and parents missing work when they stay home to take care of their children. Most children now are vaccinated with at least one dose of varicella vaccine but because one dose of the vaccine is 80-85% effective for preventing chickenpox, it is not unusual to see breakthrough disease. Two doses of varicella vaccine are now routinely recommended for children.

Background

Chickenpox is a very contagious infection caused by a virus. It is spread from person to person by direct contact or through the air from an infected person's coughing or sneezing. It causes a blister-like rash, itching, tiredness, and fever lasting an average of 4 to 6 days. Most children recover without any problems. Chickenpox can be spread for 1-2 days before the rash starts and until all blisters are crusted or no new lesions appear within a 24-hour period. It takes between 10-21 days after contact with an infected person for someone to develop chickenpox. Chickenpox in vaccinated persons is generally mild, with a shorter duration of illness and fewer than 50 lesions. The rash may be atypical with red bumps and few or no blisters.

What should you do?

_____ (*insert name of health department*) strongly encourages you to have your child receive their first or second dose of varicella vaccine if your child has not been vaccinated and has never had chickenpox. For children who had received 1 dose, a second dose is recommended.

If your child or anyone in your household currently has symptoms that look like chickenpox:

1. Contact your regular health care provider to discuss your child's symptoms and to see if anyone in the home needs to be vaccinated.
2. Contact the school nurse to report your child's chickenpox.
3. Anyone who has chickenpox should avoid contact with others who have not had chickenpox or who are not vaccinated against chickenpox. They should not attend school, day care, work, parties and/or other gatherings until the blisters become crusted (about 4-6 days after rash appears), or no new lesions appear within a 24-hours period. Keep all chickenpox spots and blisters and other wounds clean and watch for possible signs of infection; including increasing redness, swelling, drainage and pain at the wound site.
4. If you or anyone else in your household has a weakened immune system or is pregnant and has never had chickenpox or the vaccine, talk with your doctor immediately.

Controlling the Outbreak

_____ (*insert name of health department*) is working with the school to implement prevention strategies. It is now recommended that children with one dose of varicella vaccine receive a second dose routinely. If your child does develop chickenpox, he/she should be kept from attending school until the rash has crusted over. We are also trying to learn more about why children develop chickenpox and how we can best prevent this disease. In the attached questionnaire, we ask a few questions about your child and whether or not he/she has had chickenpox or received the varicella vaccine. Please complete and return the questionnaire as soon as possible.

If you have any further questions or concerns, you can contact (*insert name of contact person*) or call (*insert contact phone number*).

XV. Appendix E: Sample varicella case investigation form

Varicella Case Investigation Form

Case Name: _____

ID Number: _____

Report Date: _____

Database Entry Date: _____

Call Log:

Date: _____	<input type="checkbox"/> Day	<input type="checkbox"/> Evening	Initials: _____	<input type="checkbox"/> L/M	<input type="checkbox"/> N/A-Busy	<input type="checkbox"/> Wrong#	<input type="checkbox"/> Disc.	<input type="checkbox"/> Completed	Init: ___
Date: _____	<input type="checkbox"/> Day	<input type="checkbox"/> Evening	Initials: _____	<input type="checkbox"/> L/M	<input type="checkbox"/> N/A-Busy	<input type="checkbox"/> Wrong#	<input type="checkbox"/> Disc.	<input type="checkbox"/> Completed	Init: ___
Date: _____	<input type="checkbox"/> Day	<input type="checkbox"/> Evening	Initials: _____	<input type="checkbox"/> L/M	<input type="checkbox"/> N/A-Busy	<input type="checkbox"/> Wrong#	<input type="checkbox"/> Disc.	<input type="checkbox"/> Completed	Init: ___
Date: _____	<input type="checkbox"/> Day	<input type="checkbox"/> Evening	Initials: _____	<input type="checkbox"/> L/M	<input type="checkbox"/> N/A-Busy	<input type="checkbox"/> Wrong#	<input type="checkbox"/> Disc.	<input type="checkbox"/> Completed	Init: ___
Date: _____	<input type="checkbox"/> Day	<input type="checkbox"/> Evening	Initials: _____	<input type="checkbox"/> L/M	<input type="checkbox"/> N/A-Busy	<input type="checkbox"/> Wrong#	<input type="checkbox"/> Disc.	<input type="checkbox"/> Completed	Init: ___

Case Status:

- Probable
- Confirmed (*check all apply*: Lab-confirmed Epi-linked to confirmed or probable case)
- Excluded: indicate reason: _____
- Pending

Notes:

Introductory Script Chickenpox Case Form

Hi, this is _____. I am working with the (*insert health department name/state*). May I speak with the parent or guardian of _____?

Hi, this is _____. I am working with the (*insert health department name/state*) and [*name of school*]. As you may already know, some children in your child's school have come down with chickenpox over the past month. We are contacting all parents or guardians of children who have had chickenpox since the beginning of this school year. The (*insert health department name/state*) is working to determine the best ways to prevent this disease. I would like to ask you some questions about your child's chickenpox illness. This will take about 15 minutes. Are you willing to answer some questions now or is there a better time to call back?

If NO: best time to call back _____

If YES:

Before we begin, I would like to tell you that all the information that you give to me will be kept confidential. No names will be used in any reports. Your participation is completely voluntary; you do not have to answer any questions that you do not want to. Whether you decided to answer the survey will not affect your child's education or healthcare in any way. I am happy to answer any questions you have now or during the survey. Do you have any questions for me now?

May we start the survey now?

Case Background Information:

May I have your name please: _____

What is your relationship to (*insert Child's name*): Parent Other _____

Did you fill out a parental survey for (*insert Child's name*)? Yes No (If **Yes**, Skip to Question 4)

1. Contact Information

Address: _____

City: _____ Zip: _____

Tel: _____

Date of Birth: _____

2. School Information (*if applicable*)

School attending: _____ Grade: _____

3. Demographics

GENDER: Male: ___ Female: ___

- RACE: African-American/Black
 Asian/Pacific Islander
 Native American/Alaskan Native
 White
 Unknown
 Other

ETHNICITY: Hispanic Non-Hispanic
 Unknown

I would like to start by asking some questions about your child's disease history and medications.

Case Investigation:

4. When did you first notice your child's rash? (Please try to remember the exact date, it is very important. Please look at a calendar to help determine date if you are not sure.) ____/____/____ (*prompt with date if necessary*)
Month Date Year

4a. Who diagnosed the current case of chickenpox? (Check one)

- Primary care provider or clinic
- Other physician or clinic, please specify _____
- Parents/friends/ relatives
- School nurse
- Other, please specify _____

5. Did your child ever have chickenpox before this case of chickenpox? Yes No Unknown

5a. *If yes*, at what age? _____ Years OR _____ Months

5b. Who diagnosed the case of chickenpox? (Check one)

- Primary care provider or clinic
- Other physician or clinic, please specify _____
- Parents/friends/ relatives
- School nurse
- Other, please specify _____

5c. Was your previous chickenpox case lab confirmed? Yes No

6. Was your child ever vaccinated with the varicella vaccine? Yes-1 Dose Yes-2 Doses No Unknown

6a. If *vaccinated*, dates of vaccination: **Dose 1:** ____/____/____ **Vaccine:** Varivax Proquad Unknown
Month Day Year

Dose 2: ____/____/____ **Vaccine:** Varivax Proquad Unknown
Month Day Year

7. Did your child take any medications prescribed by a doctor during the 30 days before the chickenpox rash appeared (include medicines taken by mouth, inhalers, and creams for the skin)? Yes No

If Yes, please list the medications and condition(s) the medication was taken for.

What is the name of the medication?	Condition(s) medication taken for	Is this a systemic medication (i.e. affects the entire body and is usually taken orally)? Yes, No, Unknown

I am going to continue by asking you several questions about your child's activities.

8. Does your child ride to or from school on a bus?
 Yes *If yes, what is the bus number/neighborhood/name of the bus driver?*

 No *If no, how does your child get to school?* _____
9. Does your child attend early care **before** school? Yes No *If Yes, name facility:* _____
10. Does your child attend extended care **after** school? Yes No *If Yes, name facility:* _____
11. Does your child participate in other activities with other children? Yes No
- 11a. *If yes, what activities has he/she participated in this school year? (check all that apply)*
- Boys scouts
 - Brownies/Girls scouts
 - Church
 - Sports specify _____
 - Physical activity facility
 - Local library
 - other, please specify _____
 - other, please specify _____
12. Was your child exposed to anyone with chickenpox or shingles at home or anywhere **other than in** school in the 3 weeks before the rash started? Yes No Don't know
- 12a. *If YES, who was the source of exposure for your child?*
- Family member or person living in the household Friends
 - Other (specify) _____
- 12b. Where was the exposure? _____

12c. Was the exposure to someone with chickenpox or shingles? (check correct box): Chickenpox Shingles

12d. What were the date(s) of your child's exposure to this person? _____
(Try to obtain this information on nonschool exposure to chickenpox/shingles that would have occurred 10-21 days (ave. 14 days) before rash onset.)

Now I'm going to ask you some specific questions about your child's chickenpox.

13. How many days did the rash last, from the start until all blisters scabbed over or no new lesions appeared within a 24-hour period (for those lesions that did not become scabs)? _____ days

14. At the most severe stage of your child's chickenpox, how many lesions were present, (read options)?

less than 50 lesions (all could be counted in 30 seconds or less). **How many?** _____

50 lesions to 249 (Some skin was affected, but there was a clear area at least as big as the child's hand)

250 lesions to 500 (some skin was affected, but clear areas were not large enough to fit the child's hand without touching other lesions.)

over 500 lesions (many lesions were present, and in some areas you could not see normal skin between areas where lesions were found)

15. How would you characterize the lesions?

15a. Were any macular/popular (red, raised bumps)? Yes No Unknown

15b. Were any vesicular (blisters)? Yes No Unknown

15c. Was the rash itchy? Yes No Unknown

15d. Did the lesions scab? Yes No Unknown

16. Where was the rash on your child's body, all over or just in one part of the body?

Generalized (all over)

If **generalized**, location of rash (check all that apply): Face/Head Arms Trunk Legs Inside Mouth

Palms Soles Other (specify):

_____ Localized (just in one area of the body), where on the body was the rash?

_____ Unknown

17. Did your child have fever at least once during the chickenpox illness? Yes No Don't know

17a. If **YES**, how was the temperature measured?

Tactile (by feel) Thermometer What was the highest temperature that you recorded?

_____ 17b. How many days in a row did your child have fever? _____ days

18. How many days was your child sick in bed? _____ days

19. How many days of school did your child miss due to chickenpox? _____ days

20. Did you contact a health care provider because of your child's chickenpox?

Yes No Don't know

XVI. Appendix F: Useful formulas for the investigation of varicella outbreaks

1) **Varicella vaccination coverage rate** =
$$\frac{\text{\# of children who have received x doses varicella vaccine}}{\text{Total \# of children eligible to receive x doses of vaccine in the study population}}$$

2) Attack rate calculations:

Varicella during the outbreak	Vaccination status at start of outbreak		
	Vaccinated	Unvaccinated	Total
Yes	a	b	a+b
No	c	d	c+d
Total	a+c	b+d	a+b+c+d

a = number of vaccinated cases (either with one or two doses)

b = number of unvaccinated cases

c = number of vaccinated non-cases (either with one or two doses)

d = number of unvaccinated non-cases.

$$\text{ARV} = \text{Attack Rate}_{\text{vaccinated}} = a/(a+c)$$

$$\text{ARU} = \text{Attack Rate}_{\text{unvaccinated}} = b/(b+d)$$

3) Vaccine effectiveness calculations:

$$\text{Vaccine effectiveness (VE) \%} = \frac{\text{Attack Rate}_{\text{unvaccinated}} - \text{Attack Rate}_{\text{vaccinated}}}{\text{Attack Rate}_{\text{unvaccinated}}} \times 100$$

For accurate estimation of the VE, calculations should generally include only persons with: 1) no history of varicella disease (those with unknown history are excluded from the calculation); 2) accurate vaccination information (if vaccinated); and 3) timely vaccination (vaccinated at ≥ 12 months of age, vaccinated ≥ 42 days before the start of the outbreak, and at least 3 month interval between 1st and 2nd dose in children < 13 years of age; 4-8 week interval in persons ≥ 13 years of age).

XVII. Appendix G: Sample of varicella surveillance worksheet

A. [Varicella surveillance worksheet](#) developed by CDC as a guide for states to use for varicella case-based surveillance.

This document can be found on the CDC website at:
<http://www.cdc.gov/chickenpox/outbreaks/downloads/manual.pdf>