Infection Control in Healthcare Personnel: Epidemiology and Control of Selected Infections Transmitted Among Healthcare Personnel and Patients

Cytomegalovirus, Diphtheria, Group A *Streptococcus*, Measles, Meningococcal Disease, Mumps, Pertussis, Rabies, Rubella, Varicella, and Special Populations: Pregnant Healthcare Personnel

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Contents

List of Tables

List of Figures

Executive Summary

This document, *Infection Control in Healthcare Personnel: Epidemiology and Control of Selected Infections Transmitted Among Healthcare Personnel and Patients*, supersedes updated sections of *Guideline for infection control in health care personnel, 1998* ("*1998 Guideline*"), *Part E: Epidemiology and Control of Selected Infections Transmitted Among Health Care Personnel and Patients*, and their corresponding recommendations in Part II of the *1998 Guideline.* Additional updated sections are forthcoming.

This update is intended for use by the leaders and staff of Occupational Health Services (OHS) and to guide OHS in the management of exposed or infected healthcare personnel (HCP) who may be contagious to others in the workplace. The updated recommendations in these sections focus on postexposure management, including postexposure prophylaxis (PEP), for exposed HCP and work restrictions for exposed or infected HCP.

The recommendations in this document update the 1998 recommendations with current guidance on the management of exposed or potentially infectious HCP. New topics in the update include expanded information regarding defining occupational exposures in healthcare settings, and descriptions of clinical features of each disease. Links are provided to current resources for diagnostic testing and recommended vaccines and criteria for evidence of immunity to vaccine-preventable diseases for HCP.

The recommendations are informed by reviews of the *1998 Guideline*; current CDC resources, guidance, and guidelines; and new resources and evidence, when available. The recommendations are classified as good practice statements based upon the expert opinions of the authors and the Healthcare Infection Control Practices Advisory Committee (HICPAC).

Introduction

Scope and Purpose

The prevention of infectious disease transmission among healthcare personnel (HCP) and patients is a critical component of safe healthcare delivery in all healthcare settings. Occupational Health Services (OHS) provides occupational infection prevention and control (IPC) expertise to a healthcare organization (HCO) and services to HCP, such as those aimed at reducing risks for acquiring infections on the job (e.g., immunizing HCP) and managing HCP infectious exposures and illnesses that prevent the transmission of infectious diseases from potentially infectious HCP to patients, HCP, and others.

In 1998, the Centers for Disease Control and Prevention (CDC) published *Guideline for infection control in health care personnel, 1998*[1] (*"1998 Guideline"*), which provided information and recommendations for OHS on the prevention of transmission of infectious diseases among HCP and patients. This update, *Infection Control in Healthcare Personnel: Epidemiology and Control of Selected Infections Transmitted Among Healthcare Personnel and Patients*, supersedes updated sections of the *1998 Guideline, Part E: Epidemiology and Control of Selected Infections Transmitted Among Health Care Personnel and Patients*, and their corresponding recommendations in Part II of the *1998 Guideline.*

Additional updated sections are forthcoming.

HCP may be exposed to contagious infectious diseases in the community or in the workplace. Only those infectious diseases that may be transmitted in healthcare settings are addressed in the update.

The updated recommendations are intended to guide OHS in the management of exposed or infected HCP who may be contagious to others in the workplace. The updated recommendations in these sections focus on postexposure management, including postexposure prophylaxis (PEP), for exposed HCP and work restrictions for exposed or infected HCP. Each section describes occupational exposures; clinical features of disease, such as the incubation period and clinical signs and symptoms; and disease testing and diagnosis.

This update does not address non-infectious elements of occupational health, such as slips, trips and falls; patient handling injuries; chemical exposures; HCP burnout; and workplace violence. This update does not provide recommendations about other aspects of IPC such as environmental infection control and isolation precautions for patients. Readers are referred to Advisory Committee on Immunization Practices (ACIP) resources for recommendations related to HCP immunization. Further, this update does not address emerging pathogens, clinical treatment, or outbreak management, nor does it describe all federal, state, and local requirements related to occupational IPC, such as those maintained by the Occupational Safety and Health Administration (OSHA).

Rationale

This update is intended to:

- provide current infection-specific guidance on the management of exposed or potentially infectious HCP, and
- prevent the transmission of infectious diseases among HCP and patients.

Audience

The recommendations in this update are intended for use by OHS leaders and staff who provide occupational IPC services to HCP.

This update may also provide relevant information to additional individuals or groups whose responsibilities affect or address occupational IPC services, such as the administrators and leaders of HCO who provide resources for the delivery and management of occupational IPC services, infection prevention departments, human resources departments, and regulatory compliance groups. The recommendations in this document are intended to benefit persons who work in healthcare settings by facilitating the prevention and management of infectious exposures and illnesses, as well as patients and others with whom infectious HCP may interact.

Definitions

In this document, "HCP" refers to all paid and unpaid persons serving in healthcare settings who have the potential for direct or indirect exposure to patients or infectious materials, including body substances; contaminated medical supplies, devices, and equipment; contaminated environmental surfaces; or contaminated air. For this document, HCP does not include dental healthcare personnel, autopsy personnel, and clinical laboratory personnel, as recommendations to address occupational IPC for these personnel are available elsewhere.[2-5]

The term "healthcare settings" refers to places where healthcare is delivered and includes, but is not limited to, acute care facilities, long-term acute care facilities, inpatient rehabilitation facilities, nursing homes and assisted living facilities, home healthcare, vehicles where healthcare is delivered (e.g., mobile clinics), and outpatient facilities, such as dialysis centers, physician offices, and others.

"OHS" is used synonymously with "Employee Health," "Employee Health Services," "Employee Health and Safety," "Occupational Health," and other such programs. OHS refers to the group, department, or program that addresses many aspects of health and safety in the workplace for HCP, including the provision of clinical services for work-related injuries, exposures, and illnesses. In healthcare settings, OHS addresses workplace hazards including communicable diseases; slips, trips and falls; patient handling injuries; chemical exposures; HCP burnout; and workplace violence.

Methods

A Workgroup of the Healthcare Infection Control Practices Advisory Committee (HICPAC) was convened to update the *1998 Guideline*. The Workgroup consists of current and former HICPAC members and representatives from professional organizations, including the American College of Occupational and Environmental Medicine (ACOEM), the Infectious Diseases Society of America (IDSA), and the Society for Healthcare Epidemiology of America (SHEA). Additional support and technical advice was provided by CDC subject matter experts, including experts at the National Institute of Occupational Safety and Health (NIOSH).

To update each section of the *1998 Guideline*, the Workgroup reviewed the *1998 Guideline* to assess which recommendations remained applicable and should be carried forward; which recommendations required alignment with other current CDC resources; and which recommendations should be archived. The Workgroup, with the assistance of CDC technical advisors and subject matter experts, conducted an informal review of current CDC resources, guidance, and guidelines (Appendix 2: Methods, Tables 1-10). The results of this review

and any subsequent updates were vetted with CDC subject matter experts to ensure appropriate harmonization across CDC (Appendix 2: Methods, Figures 1-10). Recommendations and supporting narratives were presented at public HICPAC meetings for review, input, and approval.

Updated recommendations and accompanying narratives for the updated sections were presented at HICPAC meetings (https://www.cdc.gov/hicpac/php/meeting-materials/index.html) in November 2017, February 2018, August 2018, November 2018, May 2019, August 2021, November 2022, June 2023, November 2023, and August 2024.[6] Following further revisions, CDC submitted the updated sections to CDC clearance for subsequent posting to Regulations.gov (http://www.regulations.gov) for public comment. The received comments were compiled and reviewed at a public HICPAC meeting. Any subsequent revisions were incorporated into the updated sections for final review and approval at a public HICPAC meeting. The final documents will be posted on the Division of Healthcare Quality Promotion (DHQP) Infection Control Guidelines and Guidance Library (https://www.cdc.gov/infection-control/hcp/guidance/index.html) website.

Background

OHS provides critical services to HCP as part of a multifaceted approach to prevent the transmission of infectious diseases in healthcare settings. OHS responsibilities include identifying and managing infectious exposures and illnesses in HCP. Each infectious disease that can be transmitted in healthcare settings has specific job-related risks for acquisition or transmission, clinical presentations, diagnostic testing, postexposure management strategies, and treatments. OHS staff must be familiar with these aspects of transmissible infectious diseases to maintain HCP safety in the workplace and prevent disease transmission.

Each section of the update provides narrative information about aspects of the pathogen or infection with which OHS staff need familiarity to identify exposures or illnesses and to offer appropriate postexposure management, including PEP and work restrictions, or treatment. General topics in the narrative for each pathogen or infection section include epidemiology of transmission in healthcare settings; referral to immunization guidance, when appropriate; defining occupational exposures; clinical features of disease; testing and diagnosis; and postexposure management and prophylaxis.

Occupational Exposures

OHS staff identify occupational exposures that pose risk for transmission of infection so that appropriate management may be implemented. Often, data that might allow for precisely defining an occupational exposure to an individual pathogen or parasite are limited. For example, precise distances and durations for an exposure that result in transmission of an infection may not be known. Hence, clearly defining when an exposure has occurred can be challenging and may require eliciting details about a sometimes-remote incident.

Establishing the occurrence of occupational exposures often requires understanding HCP adherence to recommended Standard and Transmission-based Precautions, including the use of personal protective equipment (PPE). When recommended infection control practices are correctly implemented, HCP are not considered “exposed” to a pathogen. However, for some highly contagious infectious diseases, monitoring of PPE-protected HCP who were in proximity to a contagious pathogen for development of disease may be recommended, as unrecognized exposure, development of disease, and subsequent transmission may pose public health risks. Determining if exposures among HCP have occurred may require collaboration with other services such as IPC, facility engineering, and others when, for example, exposure to contaminated air may

require understanding airflow patterns between different areas in the healthcare setting and the rate of pathogen clearance from the air.[7]

Occupational IPC Strategies for OHS

General strategies used for occupational IPC by OHS are discussed in *Infection Control in Healthcare Personnel: Infrastructure and Routine Practices for Occupational Infection Prevention and Control Services* (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-infrastructure-routine-practices/index.html). Pathogen-specific prevention strategies include ensuring HCP have received recommended immunizations and have evidence of immunity to vaccine-preventable diseases. Strategies used by OHS to prevent disease in exposed HCP, or transmission from infectious HCP, include providing postexposure prophylaxis and applying work restrictions. In addition, for selected pathogens, decolonization of HCP may be appropriate.

Work Restrictions

Work restrictions are implemented when HCP may be potentially infectious to others or when HCP are at increased risk for acquiring infection, such as restricting susceptible HCP contact with patients with varicella zoster when immune HCP are available. Exclusion can be based on a standardized timeframe or until the results of an evaluation determine clearance to return to work, depending on the infection. Reluctance to report exposures and illnesses and concerns regarding missed work can make work restrictions difficult to implement. Staffing limitations can also affect implementation of work restrictions. Alternative work options that minimize risk to others (e.g., telework for infectious workers), and utilizing paid sick leave days or job-protected leave (e.g., provided by the Family and Medical Leave Act of 1993 (FMLA)) may reduce the negative impacts of work restrictions.

Monitoring

OHS may monitor HCP for illness following a potentially infectious exposure or after caring for patients with highly infectious diseases. In addition to evaluating for development of signs and symptoms of disease, appropriate monitoring may include postexposure testing, ongoing postexposure counseling, and check-ins on tolerability of and adherence to PEP. Monitoring strategies can range from passive to active approaches. Passive approaches to HCP monitoring might include encouraging HCP self-reporting of signs or symptoms of disease to OHS, while active approaches might include OHS telephone and video calls to HCP for symptom and temperature check-ins or in-person presentation to OHS for regular assessments. Ultimately, the selected monitoring strategy is usually situation-specific, and depends on factors such as the infrastructure and support available for HCP monitoring, HCP job tasks and risks for transmission to others, the potential severity of illness and contagiousness of the infection, and the nature of the exposure.

Immunocompromised HCP

OHS also manage immunocompromised HCP (i.e., those with an immunodeficiency or altered immunocompetence) who may be at greater risk not only to acquire or transmit infections, but also for developing more severe disease if exposed. Immunocompromise may also decrease the accuracy of laboratory tests for infection, such as those used for baseline tuberculosis (TB) screening, and may affect the safety and effectiveness of recommended vaccines; the Advisory Committee on Immunization Practices (ACIP) website (https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/immunocompetence.html) provides information to define altered immunocompetence and how it may affect immunization practices.[8]

Immunodeficiencies that may affect occupational infection prevention and control include primary (i.e., congenital) and secondary (i.e., acquired). Examples of primary immunodeficiencies include X-linked agammaglobulinemia and chronic granulomatous disease. Secondary immunodeficiencies are more common in HCP, and examples include immunodeficiency due to hematopoietic malignancies and treatment of conditions (e.g., solid organ transplantation, rheumatoid arthritis) with immunosuppressive drugs such as prednisone, monoclonal antibodies, and immunomodulatory agents. Often, data are limited to inform which immunodeficiencies should affect implementation of occupational IPC.

Some conditions, such as combined primary immunodeficiency syndromes, being on chemotherapy for cancer, untreated HIV infection with CD4 T lymphocyte count <200cells/mm^3, and receipt of prednisone >20mg/day for more than 14 days, may cause a higher degree of immunocompromise and require actions such as lengthening the duration of HCP work restrictions for some infections to prevent transmission to from HCP to others. Other factors, such as advanced age, diabetes mellitus, or end-stage renal disease, may pose a much lower degree of immunocompromise and not clearly affect OHS actions to prevent disease transmission.[9] Ultimately, the degree of immunocompromise for HCP is determined by the treating provider, and preventive actions are tailored to each individual and situation.

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Cytomegalovirus

Recommendations

1. Work restrictions are not necessary for healthcare personnel who have an exposure to cytomegalovirus.
2. Work restrictions are not necessary for healthcare personnel with active cytomegalovirus infection.

For recommendations about healthcare personnel (HCP) who are pregnant or intending to become pregnant and who might be exposed to cytomegalovirus, please see the **Pregnant HCP** (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-epidemiology-control/pregnant-hcp.html) section.

Narrative

Background

Cytomegalovirus (CMV) is a member of the herpesvirus family, which also includes herpes simplex virus types 1 and 2, varicella-zoster virus, and Epstein-Barr virus.[1] CMV infection is common, with over half of adults infected by age 40 years.[2] Transmission of CMV between healthcare personnel (HCP) and patients in healthcare settings is possible, but has not been well documented.[3] Transmission via touch from HCP or other infected persons has been suggested.[4,5] However, HCP have not been demonstrated to be at greater risk for acquiring CMV than the general population.[6-11]

Occupational Exposures

Transmission of CMV occurs through deposition of infectious body fluids (e.g., urine, saliva, blood, tears, semen, breast milk) from an infected source person onto the mucus membranes of a susceptible host.[1] Several case reports suggest that HCP who developed primary CMV infection did not acquire it from the infected children for whom they provided care, based on genomic analyses of isolates.[12-15] Hence, occupational transmission of CMV in healthcare settings may be very rare.

Using infection prevention and control practices as recommended by CDC (https://www.cdc.gov/infection-control/hcp/isolation-precautions/appendix-a-type-duration.html#C) prevents transmission of CMV in healthcare settings.[1,16]

Clinical Features

Although most people with primary CMV infection are asymptomatic or have mild symptoms,[3,17] some may experience a mononucleosis-like condition with prolonged fever and hepatitis.[1] After initial infection with CMV, the virus establishes lifelong latency and may occasionally reactivate.[1,17] Disease from reactivation of CMV infection rarely occurs unless the person's immune system is suppressed due to therapeutic drugs or disease.[1]

For most people, CMV infection is not a serious health problem. However, certain groups are at high risk for serious complications from CMV infection, including: 1. Infants infected in utero (i.e., congenital CMV); 2. Very low birth weight and premature infants; 3. People with compromised immune systems (e.g., due to organ and bone marrow transplants, advanced HIV infection).[1]

For most healthy people who acquire CMV after birth, there are few symptoms and no long-term health consequences.[1]

Testing and Diagnosis

Testing HCP for CMV infection is not typically performed by Occupational Health Services (OHS) nor indicated for most HCP, regardless of symptoms or potential exposure. Information on testing and diagnosis for CMV infection can be found on the CDC website (https://www.cdc.gov/cytomegalovirus/php/laboratories/index.html).[18]

Additional Considerations

Post-exposure prophylaxis (PEP) is not administered after exposure to CMV. No treatment for CMV infection in healthy adults is indicated.[1,17] For pregnant or immunocompromised HCP who develop signs and symptoms compatible with CMV infection, referral to their obstetric provider [see **Pregnant HCP** (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-epidemiology-control/pregnant-hcp.html) section], infectious diseases specialist, or transplant team may be indicated for counseling or to discuss the possible need for further diagnostic testing and management.[17]

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Diphtheria

Recommendations

1. For healthcare personnel who have an exposure to diphtheria, regardless of vaccination status:
    - Administer postexposure prophylaxis in accordance with CDC recommendations.
    - Exclude from work and obtain nasal and pharyngeal swabs for diphtheria culture.
        - If nasal AND pharyngeal cultures are negative for toxin-producing *C. diphtheriae*, healthcare personnel may return to work while completing postexposure antibiotic therapy.
        - If nasal OR pharyngeal cultures are positive for toxin-producing *C. diphtheriae*:
            - Complete postexposure antibiotic therapy.
            - Healthcare personnel may return to work when:
                - Postexposure antibiotic therapy is completed AND
                - At least 24 hours after completion of postexposure antibiotic therapy, two consecutive pairs of nasal AND pharyngeal cultures, obtained at least 24 hours apart, are negative for toxin-producing *C. diphtheriae*.
    - Implement daily monitoring for the development of signs and symptoms of diphtheria for 7 days after the last exposure.
2. For healthcare personnel with respiratory diphtheria infection, exclude from work until:
    - Antibiotic and antitoxin (if needed) therapy are completed AND
    - At least 24 hours after completion of antibiotic therapy, two consecutive pairs of nasal AND pharyngeal cultures, obtained at least 24 hours apart, are negative for toxin-producing *C. diphtheriae*.
3. For healthcare personnel with cutaneous diphtheria infection or other diphtheria infection manifestations, determine the duration of exclusion from work in consultation with federal, state, and local public health authorities.

Narrative

Background

Healthcare-associated transmission of diphtheria has been reported, although diphtheria is uncommon in the United States.[1-5] Diphtheria remains endemic in many parts of the developing world, and ongoing circulation of toxigenic *Corynebacterium diphtheriae* (*C. diphtheriae*) strains has been reported in North America.[2,6,7] Healthcare personnel (HCP) are not at substantially higher risk than the general adult population for acquiring diphtheria; however, there is the potential for sporadic or imported cases to require medical care in the United States. Some cases in the United States have been related to importation.[2,6,8,9]

Prevention of transmission of *C. diphtheriae* in healthcare settings involves:

a. encouraging vaccination of HCP against diphtheria in compliance with routine adult vaccine schedules[10,11];
b. in addition to using Standard Precautions, placing patients with known or suspected respiratory diphtheria on Droplet Precautions and placing patients with known or suspected cutaneous diphtheria on Contact Precautions[12];

c. rapidly diagnosing and treating patients with clinical infection;
d. administering postexposure prophylaxis (PEP) to persons exposed to diphtheria; and
e. excluding potentially infectious HCP from work.

Guidelines for diphtheria vaccination of adults are maintained by the Advisory Committee on Immunization Practices (ACIP) in ACIP Recommendations: Diphtheria, Tetanus and Pertussis (DTaP/Tdap/Td) Vaccines | ACIP Recommendations | CDC (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/dtap-tdap-td.html).[13]

Occupational Exposures

Transmission of diphtheria occurs through the deposition of respiratory, oral, or nasal secretions, discharge from skin lesions, or, rarely, fomites from an infected source person on the mucus membranes of a susceptible host.[2] Unprotected (e.g., not wearing a facemask), close, face-to-face contact with an infectious source person or their secretions may be considered an exposure to diphtheria. Close contact may include, but is not limited to, performing a physical examination on, feeding, or bathing a patient; bronchoscopy; intubation; or administration of bronchodilators.

Exposure to cutaneous diphtheria lesions may include unprotected contact with the lesions or their drainage, such as when changing lesion dressings or handling potentially infectious secretions without wearing recommended personal protective equipment (PPE) (i.e., gown and gloves).

Clinical Features

Diphtheria is an acute, toxin-mediated disease caused by *C. diphtheriae*. Toxin-producing strains of *C. diphtheriae* can cause a spectrum of disease ranging from mild to severe.[14] The overall case-fatality rate for diphtheria is 5%-10%, with higher death rates (up to 20%) among persons younger than 5 and older than 40 years of age. The incubation period is usually 2-5 days, with a range of 1-10 days.[14,15]

Diphtheria can involve almost any mucus membrane.[14] Diphtheria infection is typically classified based on the site of disease: respiratory diphtheria, including nasal, pharyngeal and tonsillar, and laryngeal diphtheria; and cutaneous diphtheria.[15] The most common sites of respiratory diphtheria infection are the pharynx and the tonsils.[14]

Initial symptoms of respiratory diphtheria include sore throat, difficulty in swallowing, malaise, and low-grade fever.[2,14] The hallmark of respiratory diphtheria is the presence of an exudate that organizes into a tough, grayish-white pseudomembrane over the tonsils, the pharynx, or larynx.[2,16] The pseudomembrane is firmly adherent to the tissue, and forcible attempts to remove it cause bleeding.[14] Cutaneous diphtheria may be characterized by a scaling rash or by ulcers with clearly demarcated edges.[14]

The most frequent complications of diphtheria are airway obstruction, myocarditis, and polyneuropathy. Most complications are attributable to effects of the toxin, which affects organs and tissues distant from the site of invasion.[14,16]

Treatment for diphtheria is begun at the first sign(s) of clinical illness.[1,14,17]

Testing and Diagnosis

Diagnostic tests used to confirm infection include isolation of toxin-producing *C. diphtheriae* by culture and toxigenicity testing. Although no other tests for diagnosing diphtheria are commercially available, CDC can

perform polymerase chain reaction (PCR) testing on clinical specimens to assist with identifying a toxigenic strain.[2] Information regarding diphtheria testing is available on the CDC Diphtheria: Laboratory website (https://www.cdc.gov/diphtheria/php/laboratories/index.html).[18]

Postexposure Prophylaxis

PEP for diphtheria includes receipt of diphtheria vaccine and a single dose of intramuscular benzathine penicillin G or a 7- to 10-day course of oral erythromycin.[1,19,20] Detailed information regarding the dosage and administration of postexposure vaccine and antimicrobial therapy is available in CDC's Information for Close Contacts: Diphtheria worksheet (https://www.cdc.gov/diphtheria/downloads/appendix-2-close-contact-form.pdf).[19]

Administration of PEP or treatment for diphtheria does not always eliminate the carrier state.[21-24] For HCP identified as toxin-producing *C. diphtheriae* carriers, positive post-treatment cultures typically prompt administration of additional courses of treatment. CDC's Information for Close Contacts: Diphtheria worksheet (https://www.cdc.gov/diphtheria/downloads/appendix-2-close-contact-form.pdf) provides additional information on the management of toxin-producing *C. diphtheriae* carriers.[15,19] Administration of PEP among contacts is generally discontinued upon culture confirmation of non-toxin-producing *C. diphtheriae* in the index case.

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Group A *Streptococcus*

Recommendations

1. Postexposure prophylaxis and work restrictions are not necessary for healthcare personnel who have an exposure to group A *Streptococcus*.
2. For healthcare personnel with known or suspected group A *Streptococcus* infection, obtain a sample from the infected site, if possible, for group A *Streptococcus* and exclude from work until group A *Streptococcus* infection is ruled out, or until 24 hours after the start of effective antimicrobial therapy, provided that any draining skin lesions can be adequately contained and covered.
    - For draining skin lesions that cannot be adequately contained or covered (e.g., on the face, neck, hands, wrists), exclude from work until the lesions are no longer draining.
3. Work restrictions are not necessary for healthcare personnel with known or suspected group A *Streptococcus* colonization, unless they are epidemiologically linked to transmission of the organism in the healthcare setting.
4. For healthcare personnel with group A *Streptococcus* colonization who are epidemiologically linked to transmission of the organism in the healthcare setting:
    - Administer chemoprophylaxis in accordance with CDC recommendations AND
    - Exclude from work until 24 hours after the start of effective antimicrobial therapy AND
    - Obtain a sample from the affected site for group A *Streptococcus* testing 7 to 10 days after completion of chemoprophylaxis; if positive, repeat administration of chemoprophylaxis and again exclude from work until 24 hours after the start of effective antimicrobial therapy.

Narrative

Background

Group A *Streptococcus* (GAS) is a bacterium that can cause many different infections, including strep throat, scarlet fever, impetigo, and others. A common cause of pharyngeal, skin, and other soft tissue infections, GAS can also cause severe, life-threatening invasive disease, including pneumonia, streptococcal toxic-shock syndrome (STSS) and necrotizing fasciitis.[1] Healthcare-associated transmission of GAS has been documented from patients to healthcare personnel (HCP) and from HCP to patients.[1-10]

Prevention of transmission of GAS in healthcare settings involves:

a. in addition to using Standard Precautions, placing patients with known or suspected GAS infection in recommended transmission-based precautions according to their clinical manifestations of GAS disease[11];
b. rapidly diagnosing and treating patients with clinical infection; and
c. excluding potentially infectious HCP from work.

Occupational Transmission

There are no recommended actions, such as administering postexposure prophylaxis (PEP) or work restrictions, after HCP exposure to GAS. Contact or dispersal of respiratory secretions are the major modes of transmission of GAS in healthcare settings.

HCP who were GAS carriers have been linked to outbreaks of surgical site, postpartum, and burn wound infections. In these outbreaks, GAS carriage was documented in the pharynx, the skin, the rectum, and the female genital tract of the colonized HCP.[1,9,12-22]

Transmission from patients to HCP has been described, with potential contributing factors including gross contamination of surgical attire during extensive wound debridement, presence of dermatitis, not using gloves when providing wound care, and sharps injury.[2,3,10,23,24]

Although rare, spread of GAS infections may also occur via food. Foodborne outbreaks of pharyngitis have occurred due to improper food handling, and HCP have been linked to foodborne transmission of GAS, causing pharyngitis.[25,26]

Clinical Features

GAS infections can have a wide variety of clinical presentations. GAS pharyngitis is fairly common and characterized by sudden-onset sore throat, pain when swallowing, fever, inflamed tonsils, petechiae on the soft or hard palate, and swollen lymph nodes in the front of the neck.[25] GAS pharyngitis is typically not associated with cough, rhinorrhea, hoarseness, or conjunctivitis – symptoms more frequently associated with viral pharyngitis.[25] Because clinical signs and symptoms of viral pharyngitis can mimic those of GAS pharyngitis, laboratory testing for GAS is necessary to make an accurate GAS pharyngitis diagnosis.[27]

Persons with GAS pharyngitis who are treated with an appropriate antibiotic are generally non-infectious after the first 24 hours of treatment.

In addition, GAS can cause an array of both superficial (e.g., impetigo) and invasive (e.g., cellulitis, abscesses) skin and soft tissue infections. Many invasive GAS infections - such as pneumonia, meningitis, necrotizing fasciitis, and STSS - are associated with high morbidity and mortality rates in the United States.[28] The portal of entry is unknown in most invasive GAS infections, but is presumed to be skin or mucous membranes.[29] Necrotizing fasciitis, a life-threatening condition, can be caused by GAS and is often initially characterized by development of a red or swollen area of skin that spreads quickly; severe pain, including pain beyond what is expected on physical examination; and fever.[30]

Toxin-producing GAS strains can cause STSS that typically manifests as a severe acute systemic illness characterized by fever, hypotension, and signs of multiorgan system failure.[29] STSS can occur without an identifiable focus of infection, although the presence of concomitant local soft tissue infection is common.[29]

The incubation period of GAS pharyngitis is approximately 2 to 5 days.[25] The incubation period is variable for other GAS infections. The incubation period for STSS has been as short as 14 hours when associated with penetrating trauma or other methods resulting in subcutaneous inoculation of organisms.[29]

Testing and Diagnosis

Because the signs and symptoms of GAS pharyngitis are similar to other infections, laboratory testing is necessary to confirm the diagnosis.[25,27] Any Clinical Laboratory Improvement Amendments (CLIA)-approved testing method for GAS pharyngitis may be used to test for infection as well as to confirm eradication of colonization among HCP. Rapid antigen detection tests (RADT) have high specificity for GAS, but varying sensitivities when compared to throat culture, which remains the gold standard diagnostic test.[25,27]

Invasive GAS disease is usually confirmed by isolation of GAS from a normally sterile body site through culture.[14]

Postexposure Considerations

Although PEP is not routinely administered after HCP exposure to GAS, if clinical symptoms compatible with GAS infection develop, GAS infection may be the underlying etiology and testing and treatment may be indicated.

Outbreaks

Even one case of postpartum or postsurgical GAS infection typically prompts an epidemiological investigation because of the potential for prevention of additional cases.[14] CDC maintains recommendations for screening HCP during GAS outbreaks in healthcare settings (https://academic.oup.com/cid/article/35/8/950/330363), including which HCP to select for screening and which body sites to culture.[14] When screening of HCP is performed, sites from which specimens are obtained and cultured include the throat, anus, vagina, and any skin lesions.[14]

Colonization with GAS does not necessitate treatment unless the carrier is epidemiologically linked to GAS transmission in the healthcare setting. Information regarding dosage and administration of chemoprophylaxis for GAS-colonized HCP who are epidemiologically linked to transmission is available in the document *Prevention of Invasive Group A Streptococcal Disease among Household Contacts of Case Patients and among Postpartum and Postsurgical Patients: Recommendations from the Centers for Disease Control and Prevention* (https://academic.oup.com/cid/article/35/8/950/330363).[14]

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Measles

Recommendations

1. For asymptomatic healthcare personnel ***with*** presumptive evidence of immunity to measles (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6204a1.htm#Tab3)[1] who have an exposure to measles:
    - Postexposure prophylaxis is not necessary.
    - Work restrictions are not necessary.
    - Implement daily monitoring for signs and symptoms of measles from the 5th day after their first exposure through the 21st day after their last exposure.
2. For asymptomatic healthcare personnel ***without*** presumptive evidence of immunity to measles who have an exposure to measles:
    - Administer postexposure prophylaxis in accordance with CDC and ACIP recommendations (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/mmr.html).[2]
    - Exclude from work from the 5th day after their first exposure through the 21st day after their last exposure, regardless of receipt of postexposure prophylaxis.
    - Work restrictions are not necessary for healthcare personnel who received the first dose of MMR vaccine prior to exposure:
        - They should receive their second dose of MMR vaccine as soon as possible (at least 28 days after their first dose).
        - Implement daily monitoring for signs and symptoms of measles from the 5th day after their first exposure through the 21st day after their last exposure.
3. For healthcare personnel with known or suspected measles, exclude from work for 4 days after the rash appears.
4. For immunocompromised healthcare personnel with known or suspected measles, exclude from work for the duration of their illness.
5. During a measles outbreak, administer measles vaccine to healthcare personnel in accordance with CDC and ACIP recommendations (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/mmr.html).[2]

Narrative

Background

Measles was declared eliminated in the US in 2000; however, community-acquired measles cases have persisted as a result of importation.[3,4] Outbreaks of measles in healthcare settings remain well described, and transmission to and from healthcare personnel (HCP) continues to be reported.[5-8] HCP are considered to be at higher risk for measles acquisition than the general population, as patients with measles often seek medical care due to the severity of their symptoms[5,9]; further, measles is highly contagious and potentially under-recognized, with delays in patient isolation and diagnosis.[7]

Prevention of transmission of measles in healthcare settings involves (a) ensuring HCP have presumptive evidence of immunity; (b) using infection prevention and control practices as recommended by CDC (https://www.cdc.gov/infection-control/hcp/isolation-precautions/appendix-a-type-duration.html#M)[10]; and (c) excluding potentially infectious HCP from work.[9,11] The criteria for presumptive evidence of immunity to measles and recommendations for measles vaccination of HCP are maintained by CDC and ACIP (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/mmr.html).[2]

Occupational Exposures

Measles is a highly contagious viral illness spread primarily via small particles that remain suspended in air. HCP exposures to measles in a healthcare setting are defined as spending any amount of time while unprotected (i.e., not wearing recommended respiratory protection):

- In a shared air space with an infectious measles patient at the same time, or
- In a shared air space vacated by an infectious measles patient for up to 2 hours.

Measles virus is thought to be contagious to others in the air for up to 2 hours.[12,13] In general, the time that the air in a room occupied by a measles patient is thought to remain infectious to others depends on several factors including the room's air changes per hour, up to a maximum of 2 hours.[14-16] Humidity and air flow dynamics between rooms may impact the efficiency of measles transmission, and distances farther from the source patient may pose decreased risk of transmission to others. An example of an exposure to measles includes HCP providing in-room care to an unmasked patient while *not* wearing recommended respiratory protection. Information on room air changes per hour and times for estimating 99.9% airborne contaminant removal from the air is provided on the CDC website, in Table B.1., "Air changes/hour (ACH) and time required for airborne-contaminant removal by efficiency" (https://www.cdc.gov/infection-control/hcp/environmental-control/appendix-b-air.html#cdc_generic_section_1-airborne-contaminant-removal).[17]

Clinical Features

Measles is characterized by a prodrome of fever, malaise, cough, coryza, conjunctivitis, and Koplik spots (clustered white lesions on the buccal mucosa), followed by onset of a maculopapular rash.[18] Because measles is uncommon in the US, providers may have a low index of suspicion for measles and ultimately delay the correct diagnosis.[19] The incubation period of measles from exposure to prodrome averages 11 - 12 days. The time from exposure to rash onset averages 14 days, with a range of 7 - 21 days.[20] Persons with measles are usually considered infectious from four days before until four days after onset of rash (with rash onset considered as day 0), and immunocompromised persons with measles may shed virus for extended periods.[20]

Testing and Diagnosis

Laboratory testing is used to confirm measles infection, and both detection of measles-specific IgM antibody and measles RNA by real-time polymerase chain reaction tests are recommended to confirm measles infection.[18] Information on measles testing is available on the CDC website (https://www.cdc.gov/measles/php/laboratories/index.html).[21]

Postexposure Prophylaxis

Exposed HCP without presumptive evidence of immunity should receive postexposure vaccination as soon as possible in accordance with CDC and ACIP recommendations. In some circumstances, immune globulin may be appropriate to offer these HCP, but this should be done in accordance with CDC and ACIP recommendations (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/mmr.html).[2]

Some HCP with documented presumptive evidence of immunity to measles will require administration of vaccine during a measles outbreak.[2] Guidance regarding postexposure and outbreak use of vaccine is available on the CDC website (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6204a1.htm).[22]

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Meningococcal Disease

Recommendations

1. Administer antimicrobial prophylaxis to healthcare personnel, regardless of vaccination status, who have an exposure to *N. meningitidis*.
2. Exclude healthcare personnel with invasive *N. meningitidis* disease from work until 24 hours after the start of effective antimicrobial therapy.
3. Work restrictions are not necessary for healthcare personnel who only have nasopharyngeal carriage of *N. meningitidis*.

Narrative

Background

Healthcare-associated transmission of *Neisseria meningitidis* (*N. meningitidis*) is uncommon. In rare instances, *N. meningitidis* has been transmitted from patients to healthcare personnel (HCP) through contact with the respiratory secretions of patients with meningococcal disease and handling isolates of *N. meningitidis*.[1-4]

Prevention of transmission of *N. meningitidis* in healthcare settings involves:

a. in addition to using Standard Precautions, placing patients with known or suspected meningococcal disease in Droplet Precautions[5];
b. rapidly diagnosing and treating patients with clinical infection;
c. appropriately administering postexposure prophylaxis (PEP) to persons exposed to *N. meningitidis*; and
d. excluding potentially infectious HCP from work.[3,5,6]

Guidelines for meningococcal vaccination of certain HCP (e.g., persons with known asplenia or persistent complement component deficiencies, personnel who are traveling to countries in which meningococcal disease is hyperendemic or epidemic) are maintained by the Advisory Committee of Immunization Practices (ACIP) and described in Immunization of Health-Care Personnel: Recommendations of the ACIP (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6007a1.htm).[3,7] Vaccination is recommended for HCP who are employed as microbiologists who are exposed routinely to isolates of *N. meningitidis*.[3,8-10] Further information about meningococcal vaccines is provided on the CDC Meningococcal: Who Needs to Be Vaccinated website (https://www.cdc.gov/vaccines/vpd/mening/hcp/who-vaccinate-hcp.html).[9]

Occupational Exposures

N. meningitidis can be transmitted person-to-person through unprotected direct contact with the respiratory secretions or saliva of a person with clinical disease, such as meningitis or bacteremia.[11,12] Exposures in healthcare may include mucous membrane contact with infectious secretions from close, face-to-face contact during activities such as mouth-to-mouth resuscitation, endotracheal tube placement or management, or open airway suctioning while not wearing or correctly using recommended personal protective equipment (PPE).[3,6,12,13]

Brief, non-face-to-face contact, such as standing in the doorway of a patient's room, cleaning a patient's room, delivering a medication or food tray, starting an IV, or performing a routine physical exam, is generally not considered an exposure.[14] Unprotected direct contact with the respiratory secretions or saliva of a person colonized with *N. meningitidis,* without clinical disease, is not considered an exposure.

Exposures to *N. meningitidis* in laboratory settings are described in *Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition* (https://stacks.cdc.gov/view/cdc/5564).[10]

Clinical Features

Meningococcal disease is a serious and potentially life-threatening infection. Common signs and symptoms of meningococcal disease include sudden onset of high fever, neck stiffness, confusion, nausea, vomiting, lethargy, and petechial or purpuric rash.[12] Without prompt and appropriate treatment, the infection can progress rapidly and result in death.[12]

Asymptomatic nasopharyngeal carriage of *N. meningitidis* is common, but few carriers develop invasive disease, and carriers without an exposure do not require treatment or chemoprophylaxis.[11-13] Persons who have close contact with persons with invasive disease are at substantially increased risk for acquiring carriage and disease.[12]

Patients infected with *N. meningitidis* may be contagious in the 7 days before symptom onset and are rendered noninfectious by 24 hours of effective antimicrobial therapy.[12,13] Cases occur in all age groups; however, children less than 2 years old, adolescents 16 through 23 years old, and adults 85 years of age or older have higher rates of disease than other age groups.[11] In addition, people with certain medical conditions, such as functional or anatomic asplenia; persistent complement component deficiencies (e.g., C3, C5-9, properdin, factor H, factor D or are taking eculizumab or ravulizumab); and HIV infection are at increased risk for meningococcal disease.[11,12,15]

The incubation period of meningococcal disease is 3 to 4 days, with a range of 1 to 10 days.

Testing and Diagnosis

Diagnosis of meningococcal disease can pose challenges because its initial clinical manifestations are similar to more common, but less serious, illnesses.[12] Hence, laboratory testing is helpful in confirming the diagnosis. *N. meningitidis* is confirmed through culture or polymerase chain reaction (PCR) of fluid collected from a normally sterile site, such as blood or cerebrospinal fluid (CSF).[16] Gram stain is still used for identification of *N. meningitidis* and continues to be a reliable and rapid method for presumptive identification, though it is not a confirmatory test.[12]

Additional information on laboratory testing for *N. meningitidis* is available on the CDC Laboratory Methods for the Diagnosis of Meningitis website (https://iris.who.int/handle/10665/70765).[17]

Postexposure Prophylaxis

Chemoprophylaxis is administered as soon as possible after exposure, ideally less than 24 hours after identification of an index patient.[13] Chemoprophylaxis administered more than 14 days after onset of illness in an index patient is probably of limited or no value.[12,13] In the event of an exposure involving a patient with possible meningococcal meningitis without microbiologic confirmation (e.g., culture negative, Gram stain negative, or lumbar puncture (LP) unable to be performed), decisions about use of PEP are made on a case-by-case basis considering the epidemiologic and clinical likelihood *of N. meningitidis* in the source patient.

Rifampin, ciprofloxacin, and ceftriaxone are 90%-95% effective in reducing nasopharyngeal carriage of *N. meningitidis* and are all acceptable antimicrobial agents for chemoprophylaxis.[13,18] Azithromycin is not routinely recommended, nor is it a first-line agent for PEP, but it may be used as chemoprophylaxis in situations such as

sustained ciprofloxacin-resistant strains of *N. meningitidis* in a community.[12,19,20] Detailed information regarding dosage and administration of PEP for *N. meningitidis* is available in the *Manual for the Surveillance of Vaccine-Preventable Diseases* (https://www.cdc.gov/surv-manual/php/table-of-contents/chapter-8-meningococcal-disease.html).[12]

Outbreaks

In the setting of a healthcare facility meningococcal disease outbreak, meningococcal vaccination or use of chemoprophylaxis in a wider group than exposed HCP may be considered in consultation with public health officials. Additional guidance regarding meningococcal disease outbreaks is described in *Guidance for the Evaluation and Public Health Management of Suspected Outbreaks of Meningococcal Disease* (https://www.cdc.gov/meningococcal/downloads/meningococcal-outbreak-guidance.pdf).[16]

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Mumps

Recommendations

1. For asymptomatic healthcare personnel ***with*** presumptive evidence of immunity to mumps (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6204a1.htm#Tab3)[1] who have an exposure to mumps:
    - Work restrictions are not necessary.
    - Implement daily monitoring for signs and symptoms of mumps from the 10th day after their first exposure through the 25th day after their last exposure.
2. For asymptomatic healthcare personnel ***without*** presumptive evidence of immunity to mumps who have an exposure to mumps:
    - Exclude from work from the 10th day after their first exposure through the 25th day after their last exposure.
    - Work restrictions are not necessary for healthcare personnel who received the first dose of MMR vaccine prior to exposure:
        - They should receive their second dose of the MMR vaccine as soon as possible (at least 28 days after their first dose).
        - Implement daily monitoring for signs and symptoms of mumps infection from the 10th day after their first exposure through the 25th day after their last exposure.
3. For healthcare personnel with known or suspected mumps, exclude from work for 5 days after the onset of parotitis.
4. For healthcare personnel with known or suspected mumps, but without parotitis, exclude from work for 5 days after onset of their first symptom.
5. During a mumps outbreak, administer mumps vaccine to healthcare personnel in accordance with CDC and ACIP recommendations (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/mmrv.html).[2]

Narrative

Background

Mumps is an acute viral illness caused by a paramyxovirus. Mumps was a common childhood illness prior to the introduction of the mumps vaccine and the implementation of mumps vaccination policies in 1977. Since then, reports of mumps cases in the US declined significantly. Starting in 2006, there has been an increase in the number of mumps cases and outbreaks reported in the United States. Most of the cases have occurred in fully vaccinated adolescents and young adults, mainly driven by outbreaks on college campuses, close-knit communities, and other congregate settings.[3-5] In the post-vaccination era, mumps transmission in healthcare settings among healthcare personnel (HCP) and patients has been reported.[6-10] Although transmission of mumps in healthcare settings is infrequent, it may be under-reported because approximately 20% of infected persons can be asymptomatic. The frequency of asymptomatic infection among vaccinated people is unknown.[3,9,11-15]

Prevention of transmission of the mumps virus in healthcare settings involves (a) ensuring HCP have presumptive evidence of immunity[16]; (b) using infection prevention and control practices as recommended by CDC (https://www.cdc.gov/infection-control/hcp/isolation-precautions/appendix-a-type-duration.html#M)[17]; and (c) excluding potentially infectious HCP from work.[3,18,19] The criteria for presumptive evidence of immunity to mumps and recommendations for mumps vaccination of HCP are maintained by CDC and ACIP (https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/mmr.html).[2]

Occupational Exposures

Transmission of mumps virus occurs through deposition of respiratory, oral, or nasal secretions from an infected source person on the mucus membranes of a susceptible host.[3] An exposure to mumps is generally defined as being within close proximity of an infectious source person (e.g., within approximately 6 feet of the patient) while unprotected (i.e., not wearing recommended personal protective equipment) or having mucous membrane contact with their secretions.[3] The risk of virus transmission may increase depending on a number of factors (e.g., decreased room ventilation, increased exposure time, closer proximity to an infectious source person).[18]

Clinical Features

The symptoms of mumps are fever and parotitis (or other salivary gland swelling), involving pain, tenderness, and swelling in one or both parotid or other salivary glands.[3,9] Mumps infection may present only with nonspecific or primarily respiratory symptoms, or may be asymptomatic; serious complications from mumps infection can occur in the absence of parotitis.[3,9] Complications of mumps include orchitis, oophoritis, mastitis, pancreatitis, hearing loss, meningitis, and encephalitis. Death from mumps is exceedingly rare. Mumps that occurs in pregnant women is not more severe than in women who are not pregnant.[20]

Parotitis onset is typically 16-18 days after exposure. The incubation period for mumps ranges from 12-25 days.[3] Mumps virus has been isolated from seven days before through 14 days after parotitis onset,[19,21] but most transmission likely occurs 2 days before and within five days of parotitis onset.[3] Mumps transmission can occur from persons with asymptomatic infection.[3,15,22-24]

Testing and Diagnosis

Reverse-transcription polymerase chain reaction (RT-PCR) on buccal specimens is the laboratory testing method of choice to confirm mumps.[25] The presence of serum mumps IgM can also be used to aid in the diagnosis of mumps infection but is not confirmatory. Laboratory confirmation of mumps in previously vaccinated or infected individuals is challenging because the viral load may be lower and less easily detected and the IgM response may be absent, delayed, or short-lived compared with unvaccinated people.[3] More detailed information on testing individuals for mumps is available on the CDC website (https://www.cdc.gov/mumps/php/laboratories/index.html).[26]

Postexposure Considerations

There is no postexposure prophylaxis (PEP) for mumps. HCP with presumptive evidence of immunity to mumps may have additional doses of vaccine recommended for them during outbreaks.[27,28] Guidance on outbreak use of the vaccine, including when to administer a third or additional dose of mumps vaccine, are provided on the CDC website (https://www.cdc.gov/mumps/php/public-health-strategy/index.html).[29]

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Pertussis

Recommendations

1. For asymptomatic healthcare personnel, regardless of vaccination status, who have an exposure to pertussis and are likely to interact with persons at increased risk for severe pertussis:
    - Administer postexposure prophylaxis.
    - If not receiving postexposure prophylaxis, restrict from contact (e.g., furlough, duty restriction, or reassignment) with patients and other persons at increased risk for severe pertussis for 21 days after the last exposure.
2. For asymptomatic healthcare personnel, regardless of vaccination status, who have an exposure to pertussis and are not likely to interact with persons at increased risk for severe pertussis:
    - Administer postexposure prophylaxis, OR
    - Implement daily monitoring for 21 days after the last exposure for development of signs and symptoms of pertussis.
3. For asymptomatic healthcare personnel, regardless of vaccination status, who have an exposure to pertussis and who have preexisting health conditions that may be exacerbated by a pertussis infection:
    - Administer postexposure prophylaxis.
4. Exclude symptomatic healthcare personnel with known or suspected pertussis from work for 21 days from the onset of cough, or until 5 days after the start of effective antimicrobial therapy.
5. Work restrictions are not necessary for asymptomatic healthcare personnel who have an exposure to pertussis and receive postexposure prophylaxis, regardless of their risk for interaction with persons at increased risk for severe pertussis.

Narrative

Background

Healthcare-associated transmission of *Bordetella pertussis* (*B. pertussis*) has involved both patients and healthcare personnel (HCP); nonimmunized infants and children are at greatest risk for severe morbidity and mortality.[1-12] Serologic studies of HCP suggest that they may be infected with pertussis much more frequently than indicated by attack rates of clinical disease.[13,14]

Prevention of transmission of *B. pertussis* in healthcare settings involves:

a. vaccinating HCP against pertussis in accordance with Advisory Committee on Immunization Practices (ACIP) recommendations[13,15];
b. in addition to using Standard Precautions, placing patients with known or suspected pertussis in Droplet Precautions[16];
c. rapidly diagnosing and treating patients with clinical infection;
d. appropriately administering postexposure prophylaxis (PEP) to persons exposed to pertussis; and
e. excluding potentially infectious HCP from work.[5,13]

Guidelines for pertussis vaccination of HCP are maintained by ACIP in Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the ACIP (https://www.cdc.gov/mmwr/volumes/67/rr/rr6702a1.htm).[13,17,18] In addition, information and recommendations addressing the potential need for revaccination of HCP with Tdap are available from the CDC

webpage Evaluating Revaccination of Healthcare Personnel with Tdap: Factors to Consider (https://www.cdc.gov/vaccines/vpd/pertussis/tdap-revac-hcp.html).[17]

Occupational Exposures

During pertussis outbreaks in healthcare settings, the risk for HCP contracting pertussis is often difficult to quantify because exposure is not well-defined.[13] Transmission of *B. pertussis* occurs through deposition of respiratory, oral, or nasal secretions from an infected source person on the mucous membranes of a susceptible host. Unprotected (e.g., not wearing a facemask), close, face-to-face contact with an infectious source person or contact with their secretions may be considered an exposure to pertussis. Close contact may include, but is not limited to, performing a physical examination on, feeding, or bathing a patient; bronchoscopy; intubation; or administration of bronchodilators. Determination of close contact may be more inclusive in settings where interaction with persons at increased risk for severe pertussis is more likely.

Clinical Features

Pertussis is highly contagious; secondary attack rates exceed 80% in susceptible household contacts.[19,20] The incubation period is usually 5 to 10 days, but symptoms may develop up to 3 weeks after exposure.[21] The clinical course of pertussis infection has 3 stages: catarrhal, paroxysmal, and convalescent.

- Stage One, the catarrhal stage (the first 1-2 weeks of infection), is characterized by symptoms such as runny nose, low-grade fever, and mild coughing. Infected persons are highly contagious in this stage, when symptoms are similar to other upper respiratory infections.
- Stage Two, the paroxysmal stage (the next 1-6 weeks; may last up to 10 weeks), is characterized by fits of rapid coughing. Rapid coughing can be followed by the typical “whoop” sound. Vomiting may occur after coughing fits (i.e., post-tussive vomiting).
- Stage Three, the convalescent stage (lasting approximately 2-3 weeks), is characterized by gradual recovery, with improving cough and fewer fits of coughing.

Populations at increased risk for serious complications and death from severe pertussis include:

- Infants aged under 12 months
- Women in their third trimester of pregnancy
- Persons with pre-existing health conditions that may be exacerbated by a pertussis infection (e.g., immunocompromised persons, persons with moderate to severe asthma).[22]

Symptomatic persons who receive effective antimicrobial therapy for pertussis are no longer contagious after 5 days of appropriate treatment.[13,23]

The period of communicability starts at the onset of the catarrhal stage and extends into the paroxysmal stage, up to 3 weeks after the onset of paroxysms.[21] Prevention of secondary transmission of pertussis is especially difficult during the early stages of the disease because pertussis is highly communicable in the catarrhal stage, when symptoms are nonspecific and the diagnosis is uncertain. Furthermore, clinical symptoms in adults and adolescents may be less severe than in children and young infants and may not be recognized as pertussis.[21]

Testing and Diagnosis

Diagnosis of pertussis is typically made based upon compatible clinical history and diagnostic laboratory testing. Although culture is considered the "gold standard" for establishing a diagnosis of pertussis, polymerase chain reaction (PCR) provides sensitive results more rapidly.[24,25] More detailed information regarding testing persons for pertussis is available on the CDC Pertussis (Whooping Cough) Diagnostic Testing website (https://www.cdc.gov/pertussis/php/laboratories/index.html).[26]

Other *Bordetella* species (e.g., *B. parapertussis*, *B. holmesii*) may be detected and can occur alone or simultaneously with *B. pertussis* infection.[27-31] Although the clinical presentation for *B. parapertussis* is similar to that of *B. pertussis*, *B. parapertussis* usually causes less severe disease, which may be related to its lack of production of pertussis toxin.[27,28,32,33] One report from 1971 estimated that 3-4% of patients with parapertussis develop clinical disease, compared to 75% with pertussis.[33] The severity of parapertussis illness among special populations, such as infants and immunocompromised persons, is unclear, with few hospitalizations and related deaths reported.[34-39] Data on the effectiveness of antibiotics for the treatment or chemoprophylaxis of *B. parapertussis* are also limited. Some states have parapertussis postexposure and illness management guidance, and some institutions choose to apply pertussis strategies for parapertussis.[25,40]

Postexposure Prophylaxis

Vaccinated HCP may still be susceptible to pertussis due to waning immunity, lack of response to the vaccine, immunosuppression, or other factors. Because vaccinated HCP may still be at risk for pertussis infection, vaccination does not preclude the need for PEP, when indicated.[13,17,18] Data on the efficacy of, and need for, PEP in Tetanus, Diphtheria, Pertussis (Tdap)-vaccinated HCP are inconclusive, but studies suggest that it may minimize transmission.[5,13,41-43] The preferred agents for postexposure prophylaxis are azithromycin, erythromycin, and clarithromycin.[44] Trimethoprim-sulfamethoxazole (TMP-SMZ) may also be used as an alternative agent. Detailed information regarding dosage and administration of PEP is available in the Recommended Antimicrobial Agents for the Treatment and Postexposure Prophylaxis of Pertussis, 2005 CDC Guidelines (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5414a1.htm).[44]

Outbreaks

Information and recommendations on the potential need for booster doses of vaccine during outbreaks or periods of increased risk for healthcare-associated transmission of pertussis can be found on the CDC Pertussis (Whooping Cough) website (https://www.cdc.gov/pertussis/outbreaks/index.html).[45]

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Rabies

Recommendations:

1. For healthcare personnel who have an exposure to rabies virus, administer postexposure prophylaxis in accordance with CDC and ACIP recommendations and in consultation with federal, state, and local public health authorities.
2. Work restrictions are not necessary for asymptomatic healthcare personnel who have an exposure to rabies virus.
3. For healthcare personnel who have a suspected or confirmed rabies virus infection, exclude from work in consultation with federal, state, and local public health authorities.

Narrative

Background

Healthcare-associated transmission of rabies virus has been documented between patients, although occupational transmission to HCP has not been confirmed.[1] Person to person transmission of rabies is rare and has been reported almost exclusively via cornea, tissue, and organ transplantation.[2,3-7]

Guidelines for rabies vaccination of certain high-risk groups (e.g., persons who perform rabies laboratory diagnostic testing, those who frequently enter high density bat environments, and persons who work with potentially rabid mammals) are maintained by the Advisory Committee on Immunization Practices (ACIP) and described in Human Rabies Prevention --- United States, 2008 Recommendations of the Advisory Committee on Immunization Practices (cdc.gov) (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5703a1.htm), with updates posted on the ACIP Vaccine Recommendations and Schedules | CDC website (https://www.cdc.gov/acip/vaccine-recommendations/index.html).[8] Additional information regarding preexposure rabies vaccination is available on the CDC Rabies Preexposure Vaccinations website (https://www.cdc.gov/rabies/hcp/prevention-recommendations/pre-exposure-prophylaxis.html).[9]

Prevention of transmission of rabies in healthcare settings involves:

a. using Standard Precautions, that may include a gown, gloves, eye protection and a facemask, for patients with suspected or confirmed clinical infection, to prevent contact with potentially infectious body fluids and secretions;
b. rapidly diagnosing patients with clinical infection;
c. appropriately administering postexposure prophylaxis (PEP) to persons exposed to rabies virus; and
d. excluding potentially infectious HCP from work.

Use of appropriate personal protective equipment is a critical part of Standard Precautions that prevents exposures among HCP and the need for PEP. Adherence to standard precautions includes wearing gowns, gloves, a facemask, and eye protection when contact with patient secretions is possible, such as during intubation, suctioning of airways, and other common patient care activities.

Occupational Exposures

Rabies virus is transmitted through direct contact (e.g., through broken skin or mucous membranes in the eyes, nose, or mouth) with saliva, tears and lacrimal secretions, or brain/nervous system tissue from an infected animal or person.[10] Bite and non-bite (e.g., cerebrospinal fluid, brain tissue) occupational exposures from an

infected person could theoretically transmit rabies to HCP, but no such cases have been confirmed. Casual contact, such as touching a person with rabies or contact with non-infectious fluid or tissue (e.g., urine, blood, feces), is not associated with a risk for infection. Rabies virus is not transmitted through contaminated objects or materials such as clothes or bedding.[11]

An exposure to rabies virus in a healthcare setting could include being bitten by a potentially infectious patient, or having a patient's saliva come into contact with a person's eyes, mouth, or an open cut on the skin. Contact with wildlife on a healthcare facility's premises, or in the community, remains possible, and HCP may have exposures outside the United States (https://wwwnc.cdc.gov/travel/yellowbook/2020/travel-related-infectious-diseases/rabies)[12] that are addressed by occupational health services upon their return. Occupational Health Services typically contact state public health officials for assistance in determining the likelihood of a rabies exposure in a specific situation before initiating post-exposure prophylaxis.[8]

Laboratory safety, exposures to rabies, and prevention in laboratory settings are described in *Biosafety in Microbiological and Biomedical Laboratories (BMBL), 6th Edition* (https://www.cdc.gov/labs/bmbl/index.html).[13]

Clinical Features

Rabies onset is characterized by a non-specific prodrome that could be mistaken for other diseases. The first symptoms of rabies may be very similar to those of an influenza-like illness, including general weakness or discomfort, fever, or headache. These symptoms may last for days. There may also be discomfort or a prickling or itching sensation at the site of an initial bite, progressing within days to symptoms of cerebral dysfunction, anxiety, confusion, autonomic instability, and agitation. As the disease progresses, the person may experience delirium, abnormal behavior, hallucinations, hydrophobia (fear of water), dysphagia, and insomnia. Occasionally, rabies may present as a paralytic syndrome.[14,15]

The acute period of disease typically ends after 2 to 10 days. Once clinical signs of rabies appear, the disease is nearly always fatal, and treatment is typically supportive.[14] Among those without a history of receiving pre- or postexposure prophylaxis, less than 10 documented cases of human survival from rabies have been reported; the majority have had significant lifelong neurological deficits.

The incubation period may vary based on the location of the exposure site (how far away it is from the brain), the type of rabies virus, and any existing immunity.[14] In humans, the incubation period averages 1 to 3 months but ranges from days to years.[16,17]

Testing and Diagnosis

Patient history is important to identify a possible exposure to rabies and other encephalitides; in the absence of a possible exposure to rabies, more common causes of encephalitis (e.g., Herpes Simplex Virus, Varicella-Zoster Virus) are typically ruled-out before rabies is considered. However, rabies, for example from an unrecognized bat bite, could be a consideration in the absence of definite exposure history when a work-up has not yielded an etiology.[18]

Several ante-mortem tests are necessary to diagnose rabies in humans; no single test is sufficient to rule out rabies in a living person. Antemortem tests are performed on samples of saliva, serum, spinal fluid, and nuchal skin biopsies that include hair follicles at the nape of the neck. Saliva can be tested by real-time reverse transcription polymerase chain reaction. Serum and spinal fluid are tested for neutralizing and non-neutralizing

antibodies to rabies virus. Skin biopsy specimens are examined for rabies antigen in the cutaneous nerves at the base of hair follicles by antigenic and molecular testing methods.[19] Interpretation of rabies virus serology can be confounded in persons with a history of rabies vaccination or those who have received human rabies immune globulin within the last 14 days; a positive serological test, alone, must be accompanied with a thorough medical history to rule out these confounders.

Additional information about testing for rabies may be found on the CDC Rabies website (https://www.cdc.gov/rabies/index.html).[20]

Postexposure Prophylaxis

The purpose of PEP is to prevent the rabies virus from establishing infection in the neural tissue of the host, and decisions about administration are usually made on a case-by-case basis after discussion with public health authorities. Contact information for consulting with state public health authorities is located on the National Association of State Public Health Veterinarians website (http://www.nasphv.org/Documents/StatePublicHealthVeterinariansByState.pdf).[21]

HCP who report an exposure to rabies may be offered PEP depending on the nature of the exposure.[16] In addition to PEP, all affected wounds should be washed promptly to reduce the amount of virus that may remain present in the wound.[8,16] Prophylaxis, when indicated, should begin as soon as possible after exposure.

Routine delivery of healthcare to a patient with rabies, without an exposure that could result in transmission, is not an indication for PEP. Additional detail regarding PEP for rabies is provided on the CDC Rabies Vaccine website (https://www.cdc.gov/rabies/hcp/prevention-recommendations/post-exposure-prophylaxis.html).[22-25]

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Rubella

Recommendations

1. For asymptomatic healthcare personnel ***with*** presumptive evidence of immunity to rubella (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6204a1.htm#Tab3)[1] who have an exposure to rubella:
    - Work restrictions are not necessary.
    - Implement daily monitoring for signs and symptoms of rubella from the 7th day after their first exposure through the 23rd day after their last exposure.
2. For asymptomatic healthcare personnel ***without*** presumptive evidence of immunity to rubella who have an exposure to rubella, exclude from work from the 7th day after their first exposure through the 23rd day after their last exposure.
3. For healthcare personnel with known or suspected rubella, exclude from work for 7 days after the rash appears.

For recommendations about healthcare personnel who are pregnant or intending to become pregnant, please see the **Pregnant HCP** (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-epidemiology-control/pregnant-hcp.html) section.

Narrative

Background

Rubella (German Measles, Three-Day Measles) is a viral rash illness that is typically mild, but that can lead to complications and death.[2] Although endemic in many countries in the world, rubella was declared eliminated in the US in 2004.[3] The US elimination of rubella was reconfirmed in 2011, and maintenance of elimination was reported in 2014.[4,5] No documented transmission of rubella to healthcare personnel (HCP) or others in US healthcare facilities has occurred since elimination was declared; however, imported cases of rubella and congenital rubella syndrome (CRS) have been reported, and HCP exposures have occurred.[6] Rubella transmission in US medical settings was documented extensively in the decades before elimination, with serious consequences, including pregnancy terminations, disruption of hospital routine, absenteeism from work, and expensive containment measures.[7-18]

Prevention of transmission of the rubella virus in healthcare settings involves (a) ensuring healthcare personnel have presumptive evidence of immunity[19]; (b) using infection prevention and control practices as recommended by CDC (https://www.cdc.gov/infection-control/hcp/isolation-precautions/appendix-a-type-duration.html#R)[20]; and (c) excluding potentially infectious HCP from work.[3,21] Recommendations for rubella vaccination of HCP are maintained by CDC and ACIP (https://www.cdc.gov/acip-recs/hcp/vaccine-specific/mmrv.html).[22]

Occupational Exposures

Transmission of rubella occurs through deposition of respiratory, oral, or nasal secretions from an infected source person on the mucus membranes of a susceptible host. An exposure to rubella is generally defined as being within close proximity of an infectious source person (e.g., within approximately 6 feet of the patient) while unprotected (i.e., not wearing recommended personal protective equipment) or having mucous membrane contact with their secretions.[3] The risk of virus transmission may increase depending on a number of

factors (e.g., decreased room ventilation, increased exposure time, closer proximity to an infectious source person).

Clinical Features

Rubella is characterized by a mild, maculopapular rash; lymphadenopathy; and fever.[2] The rash occurs in 50% to 80% of infected people and usually starts on the face, becomes generalized within 24 hours, and lasts a median of 3 days.[2] Many rubella infections are not recognized because the rash resembles other rash illnesses.[2] When rubella infection occurs during pregnancy, especially during the first trimester, congenital infection and serious consequences can result, including miscarriages, stillbirths and fetal deaths, and severe birth defects.[3] Additional complications of rubella include arthralgia or arthritis, which may occur in up to 70% of adult women with rubella, and rarely thrombocytopenic purpura and encephalitis.[2]

The average incubation period of rubella virus is 17 days, with a range of 12 to 23 days.[2] Persons with rubella are most infectious when the rash is erupting, but they can shed virus from 7 days before to 7 days after rash onset.[2,3] Certain populations infected with rubella, such as infants with Congenital Rubella Syndrome, may excrete virus for prolonged periods, which may extend their infectious period.[6,23] Approximately 25% - 50% of rubella infections are asymptomatic.[2]

Testing and Diagnosis

Clinical diagnosis of rubella is unreliable; therefore, cases are laboratory confirmed.[3] Options for rubella testing include detection of the virus by Polymerase Chain Reaction (PCR), the presence of rubella-specific IgM antibody, or demonstration of a significant rise in IgG antibody from paired acute- and convalescent-phase sera.[23] Virus detection and serologic testing can be used to confirm acute or recent rubella infection.[3] Information on laboratory testing for rubella is available on the CDC website (https://www.cdc.gov/rubella/php/laboratories/index.html).[24]

Postexposure Prophylaxis

No evidence exists that postexposure vaccination is effective in preventing rubella infection.[7,23] and PEP after exposure to rubella is not typically offered. Due to the lack of evidence, even if HCP receive postexposure vaccination, they are still excluded from work as is recommended for those without presumptive evidence of immunity to rubella.

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Varicella-Zoster Virus

Recommendations

1. For asymptomatic healthcare personnel ***with*** evidence of immunity to varicella (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm#box)[1] who have an exposure to varicella (chickenpox) or disseminated or localized herpes zoster (shingles):
    - Postexposure prophylaxis is not necessary.
    - Work restrictions are not necessary.
    - Implement daily monitoring for signs and symptoms of varicella from the 8th day after the first exposure through the 21st day after the last exposure.
2. For asymptomatic healthcare personnel ***without*** evidence of immunity to varicella who have an exposure to varicella (chickenpox) or disseminated or localized herpes zoster (shingles):
    - Administer postexposure prophylaxis in accordance with CDC and ACIP recommendations (https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6228a4.htm; https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm).[2,3]
    - Exclude from work from the 8th day after the first exposure through the 21st day after the last exposure.
        - Work restrictions are not necessary for healthcare personnel who received one dose of the varicella vaccine prior to exposure if they receive the second dose of vaccine within 5 days after exposure.
            - Implement daily monitoring for signs and symptoms of varicella from the 8th day after the first exposure through the 21st day after the last exposure.
        - If varicella-zoster immune globulin is administered as postexposure prophylaxis, exclude from work from the 8th day after the first exposure through the 28th day after the last exposure.
3. For healthcare personnel with varicella (chickenpox), exclude from work until all lesions have dried and crusted; or, for those who only have non-vesicular lesions that do not crust, exclude from work until no new lesions appear within a 24-hour period.
4. For healthcare personnel with disseminated herpes zoster (shingles) or for immunocompromised healthcare personnel with localized herpes zoster until disseminated disease has been ruled out, exclude from work until all lesions have dried and crusted.
5. For immunocompetent healthcare personnel who have localized herpes zoster (shingles), including vaccine-strain herpes zoster, and for immunocompromised healthcare personnel who have localized herpes zoster and have had disseminated disease ruled out:
    - Cover all lesions and, when feasible, exclude from direct care of patients at high risk for severe varicella (e.g., in protective environments) until all lesions are dried and crusted.
    - If lesions cannot be covered (e.g., on the hands or face), exclude from work until all lesions have dried and crusted.

For recommendations about healthcare personnel who are pregnant or intending to become pregnant, please see the **Pregnant HCP** (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-epidemiology-control/pregnant-hcp.html) section.

Narrative

Background

Varicella-zoster virus (VZV) is a DNA virus that is a member of the herpesvirus group. Primary infection with VZV causes varicella (chickenpox), and reactivation of latent infection causes herpes zoster (shingles). Healthcare-associated transmission of VZV is well recognized,[4,5] although reports of transmission in healthcare settings have become less common since the introduction of the varicella vaccine.[6-9] Sources for healthcare-associated transmission include patients, healthcare personnel (HCP), and visitors with either varicella or herpes zoster.[10]

Prevention of transmission of VZV in healthcare settings involves (a) ensuring HCP have evidence of immunity to varicella[11]; (b) using infection prevention and control practices as recommended by CDC (https://www.cdc.gov/infection-control/hcp/isolation-precautions/appendix-a-type-duration.html#V)[12]; (c) administering postexposure prophylaxis (PEP) to susceptible HCP exposed to varicella or herpes zoster; and (d) excluding potentially infectious HCP from work.[13] CDC recommends that susceptible HCP should not enter the room of a patient with varicella, disseminated herpes zoster, or localized herpes zoster if immune caregivers are available.[14]

The criteria for evidence of immunity to varicella (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm#box)[1] and recommendations for varicella vaccination of HCP (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm; https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6007a1.htm)[3,10] are maintained by CDC and the Advisory Committee on Immunization Practices (ACIP).

Occupational Exposures

VZV can be spread from person to person by direct contact, inhalation of small particles from vesicular fluid of skin lesions of acute varicella or herpes zoster that remain suspended in the air, and possibly through infectious respiratory secretions from patients with varicella that also may be suspended in the air.[15]

Varicella and Disseminated Herpes Zoster

Unprotected (e.g., not wearing recommended personal protective equipment) contact with patients with varicella or disseminated herpes zoster, their secretions, or air containing infectious particles is typically considered an exposure to VZV. Exposures in healthcare settings may include unprotected entry into a source patient's room (or shared air space) or touching vesicular fluid from skin lesions without personal protective equipment. Experts differ regarding the duration of exposure to an infectious patient (e.g., being in the same room) that is needed for transmission. Sources suggest time frames from 5 minutes to up to 1 hour.[3] Using a shorter time frame (e.g., 5 minutes) for considering an unprotected HCP to be exposed, might better ensure that HCP at risk for developing disease are identified. Brief, unprotected entry into a source patient's room (or shared air space) without touching the patient or surfaces is generally not considered an exposure.

Localized Herpes Zoster

VZV can also spread from a person with active localized herpes zoster to cause varicella in a susceptible person (i.e., who has never had varicella or has not received varicella vaccine).[16] The lesions of localized (or disseminated) herpes zoster are infectious until they dry and crust over; covering the lesions reduces the risk of transmission to others.

For HCP with localized herpes zoster, covering lesions serves the two-fold purpose of reducing the risk of transmission to others, as well as protecting the compromised skin from contamination and potential secondary infection. Data on the efficacy of one type of covering (e.g., sterile bandage, gauze, clothing, etc.) versus another for preventing virus transmission are limited.[17,18] Some facilities have policies regarding what types of dressings may be used to cover lesions for HCP with localized herpes zoster to report to work.

Clinical Features

Varicella, or chickenpox, is the acute, infectious febrile rash illness that results from primary infection with VZV.[19,20] After primary infection, VZV establishes latency in the sensory nerve ganglia. Herpes zoster, or shingles, is the reactivation of latent VZV and occurs in approximately one-third of those infected over their lifetime.

The incubation period for varicella is on average 14 to 16 days after exposure to a varicella or a herpes zoster rash, with a range of 10 to 21 days.[21] A person with varicella is considered contagious from 1-2 days before rash onset until all lesions have crusted.[21] A person with active herpes zoster is contagious when the rash is vesicular, and no longer infectious to others once the rash has crusted over.[16] Herpes zoster is less contagious than varicella, and the risk of a person with herpes zoster spreading the virus is low if the rash is covered.[14,16]

A varicella-like rash can occur at the injection site after receipt of varicella vaccine and is generally self-limited. Transmission of vaccine virus to others is rare.[19,22] More information about the transmission of vaccine virus can be accessed from the CDC website (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm).[3]

Varicella (chickenpox)

Varicella is highly contagious, with secondary infection occurring in 61-100% of susceptible household contacts. Varicella is characterized by a pruritic, maculopapular vesicular rash that evolves into noninfectious dried crusts over a 4-7 day period.[20] A mild prodrome of fever and malaise may occur 1 to 2 days before rash onset, particularly in adults.[21] Acute varicella is generally mild and self-limited, but it may be associated with complications.[19] Immunocompromised people and pregnant women without evidence of immunity to varicella are at increased risk for severe varicella (https://www.cdc.gov/chickenpox/hcp/clinical-guidance/index.html).[23] Examples of immunocompromised HCP at high risk for severe varicella include those with leukemia or lymphoma, cellular immune-deficiencies, and on medications that suppress the immune system such as high dose steroids or chemotherapeutic agents.[15] Immunocompromised persons are at risk for developing visceral dissemination, pneumonia, hepatitis, encephalitis, and disseminated intravascular coagulopathy.[23] In addition, they can present with increased numbers of skin lesions that may be atypical (i.e., hemorrhagic), that can continue to develop, and that can have longer duration than immunocompetent hosts with varicella. Pregnant women without evidence of immunity to varicella are at risk for complications of varicella, such as VZV pneumonia, with increased frequency and severity in the 3rd trimester. If an individual develops varicella in the first or early second trimester of pregnancy, the baby is at risk for congenital varicella syndrome; if the individual develops a varicella rash from 5 days before to 2 days after delivery, the baby is at risk for neonatal varicella.[23]

Breakthrough varicella is infection occurring in a vaccinated person more than 42 days post-vaccination.[21] Breakthrough disease is generally milder than disease in unvaccinated persons, often with fewer than 50 skin lesions, mostly maculopapular with few vesicles, compared with 300 or more skin lesions, mostly vesicular in unvaccinated persons.[21] Given its modified clinical presentation, breakthrough varicella can be challenging for

practitioners to recognize. Persons with breakthrough disease are still contagious to others, though they usually are less so than unvaccinated persons with varicella.[21,24]

Herpes zoster (shingles)

Herpes zoster usually presents as a vesicular rash with pain and itching in a localized dermatomal distribution.[25] The rash may also be disseminated – defined as the appearance of lesions outside the primary or adjacent dermatomes – mainly in immunocompromised persons.[25] Postherpetic neuralgia (PHN), or pain in the area of the rash that persists after the lesions have resolved, is a complication of herpes zoster.[19,25]

Testing and Diagnosis

The clinical diagnosis of varicella has become increasingly challenging as a growing proportion of cases occur in vaccinated persons in whom disease is mild and modified, and HCP encounter patients with varicella less frequently.[3,26] Given these factors, laboratory testing to confirm the diagnosis in affected HCP has become increasingly important. Polymerase chain reaction (PCR) is the laboratory testing method of choice to confirm varicella. Ideal samples for testing are vesicular fluid or crusts from skin lesions.[27,28] VZV may also be isolated in tissue culture, although this method is less sensitive and requires several days to obtain results.[19,20]

The signs and symptoms of herpes zoster are usually distinctive enough to make an accurate clinical diagnosis once the rash has appeared.[29] However, clinical diagnosis of herpes zoster might not be possible in the absence of a rash, and laboratory testing can confirm VZV infection when the rash may be similar in appearance to other diseases, such as herpes simplex virus.[29-31]

Additional information regarding VZV testing is available on the CDC website (https://www.cdc.gov/chickenpox/php/laboratories/index.html)[32] and (https://www.cdc.gov/shingles/hcp/clinical-overview/index.html#cdc_clinical_overview_test_dia-testing).[29]

Postexposure Prophylaxis (PEP)

ACIP recommends that exposed HCP without evidence of immunity to varicella receive postexposure vaccination as soon as possible (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm)[3] Vaccination within 3 to 5 days of exposure may modify the disease if infection occurs.[3] Vaccination 6 or more days after exposure is still indicated because it induces protection against subsequent exposures.[3]

For HCP without evidence of immunity to varicella who have a contraindication to varicella vaccination and are at increased risk for severe disease (e.g., pregnant, immunocompromised), varicella-zoster immune globulin is recommended to be administered as soon as possible (within 10 days) after exposure to VZV.[2,3] Administration of immune globulin can prolong the incubation period to 28 days after exposure.[2] Detailed information regarding dosage and administration of PEP is available on the CDC website (https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6228a4.htm; https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5604a1.htm).[2,3,33]

Considerations for When HCP with Localized Herpes Zoster Continue to Work

For immunocompetent HCP with localized herpes zoster that can be completely covered, risk for transmission to patients or other HCP is low, and these HCP typically remain at work. Restricting these HCP from providing direct care to those at high risk for severe varicella (https://www.cdc.gov/chickenpox/hcp/clinical-guidance/index.html)[23] might provide an added layer of protection for these patients, but is not readily implemented when these patients are not easily identified (e.g., evidence of immunity to varicella is unknown). Hence, restricting these HCP from caring for patients at high risk for severe varicella may be reasonably applied in selected situations (e.g., restricted from caring for patients placed in a protective environment, such as a hematopoietic stem cell transplant unit or neonatal intensive care unit).

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Special Populations: Pregnant Healthcare Personnel

Recommendations

1. Do not routinely exclude healthcare personnel only on the basis of their pregnancy or intent to be pregnant from the care of patients with infections that have potential to harm the fetus (e.g., Cytomegalovirus (CMV), Human Immunodeficiency Virus (HIV), viral hepatitis, herpes simplex, parvovirus, rubella, varicella)

For recommendations and additional information about counseling healthcare personnel, including those who are pregnant or intending to become pregnant, please see Section 1, **Medical Evaluations** (https://www.cdc.gov/infection-control/hcp/healthcare-personnel-infrastructure-routine-practices/medical-evaluations.html).

Narrative

Background

Pregnant healthcare personnel (HCP) are temporarily immunocompromised, and occupational acquisition of infections is of special concern to HCP of childbearing age and occupational health services (OHS) for several reasons. In general, pregnant HCP do not have an increased risk for acquiring infections in the workplace, and pregnancy itself does not change HCP risk for exposure to infectious diseases; however, pregnancy may make persons at higher risk for complications of some diseases, such as varicella and the risk for developing pneumonia, and may pose risks to their fetus, such as development of congenital varicella syndrome.[1]

Pregnancy affects the safety of administering some recommended immunizations and may require OHS to wait until pregnancy is over for administration. Live vaccines administered to pregnant HCP pose a theoretical risk to the fetus; therefore, live, attenuated virus and live bacterial vaccines are generally contraindicated during pregnancy. However, all inactivated viral and bacterial vaccines and immunoglobulin preparations [e.g., Hepatitis B Immune Globulin (HBIV), Varicella Zoster Immune Globulin (VARIZIG)] may be administered, if indicated, to pregnant HCP. Further, Tetanus, Diphtheria, Pertussis (Tdap); inactivated influenza; and COVID-19 vaccines are specifically indicated for pregnant women.[2]

Counseling of pregnant HCP and those planning to become pregnant is recommended as a part of providing episodic medical evaluations to HCP, and is paramount for safety in the workplace (see Section 1, **Medical Evaluations**, https://www.cdc.gov/infection-control/hcp/healthcare-personnel-infrastructure-routine-practices/medical-evaluations.html).[3] Such counseling typically covers the risk of transmission of diseases (e.g., CMV, hepatitis, herpes simplex, HIV, parvovirus, rubella, varicella) that, if acquired during pregnancy, may have adverse effects on the fetus, as well as recommended infection prevention and control measures to prevent transmission. Routine exclusions from caring for patients with infections that have the potential to harm the fetus are not typically applied to HCP only on the basis of their pregnancy or intent to be pregnant because recommended precautions protect HCP from transmission. However, work restrictions for pregnant HCP may be recommended by public health authorities for some novel or high consequence pathogens.

When pregnant HCP or those intending to become pregnant have an occupational exposure or occupational acquisition of an infectious disease, OHS will typically refer the individual to their obstetric provider so that recommended treatment, postexposure management, and counseling can be collaboratively delivered. Inclusion of an individual's obstetric provider (e.g., obstetrician, family medicine provider, midwife) in their medical care is critical for their safety and health.

References

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2. Centers for Disease Control and Prevention. Vaccine Recommendations and Guidelines of the ACIP: Special Situations: Vaccination During Pregnancy. Updated July 12, 2022. Accessed November 17, 2022, https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/special-situations.html#pregnancy
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Appendix 1: Abbreviations and Acronyms

Acronym	Expansion
ACH	Air Changes per Hour
ACIP	Advisory Committee on Immunization Practices
ACOEM	American College of Occupational and Environmental Medicine
B. pertussis	*Bordetella pertussis*
BMBL	Biosafety in Microbiological and Biomedical Laboratories
CDC	Centers for Disease Control and Prevention
CLIA	Clinical Laboratory Improvement Amendments
CMV	Cytomegalovirus
CRS	Congenital Rubella Syndrome
DHQP	Division of Healthcare Quality Promotion
CSF	Cerebrospinal Fluid
FMLA	Family and Medical Leave Act of 1993
GAS	Group A *Streptococcus*
HBIV	Hepatitis B Immune Globulin
HCO	Healthcare Organization
HCP	Healthcare Personnel
HICPAC	Healthcare Infection Control Practices Advisory Committee
HIV	Human Immunodeficiency Virus
IDSA	Infectious Diseases Society of America
IgG	Immunoglobulin G
IgM	Immunoglobulin M
IPC	Infection Prevention and Control
IV	Intravenous
LP	Lumbar Puncture
MMR	Measles, Mumps, and Rubella
N. meningitidis	*Neisseria meningitidis*
NIOSH	National Institute of Occupational Safety and Health
OHS	Occupational Health Services
OSHA	Occupational Safety and Health Administration
PCR	Polymerase Chain Reaction
PEP	Postexposure Prophylaxis
PPE	Personal Protective Equipment
RADT	Rapid Antigen Detection Test
RNA	Ribonucleic Acid
RT	Reverse Transcription
RT-PCR	Reverse-Transcription Polymerase Chain Reaction
SHEA	Society for Healthcare Epidemiology of America
STSS	Streptococcal Toxic-Shock Syndrome
TB	Tuberculosis
Tdap	Tetanus, Diphtheria, Pertussis
TMP-SMZ	Trimethoprim-sulfamethoxazole
US	United States
VARIZIG	Varicella Zoster Immune Globulin
VZV	Varicella-Zoster Virus

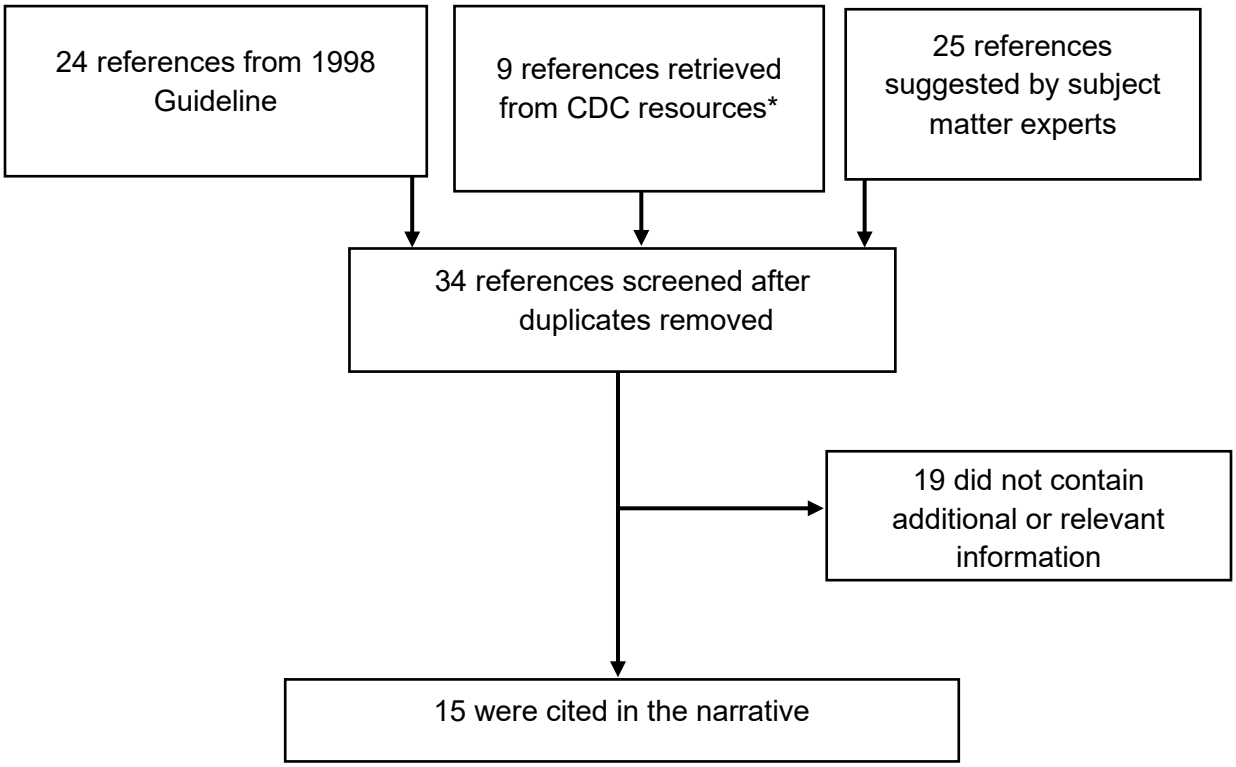
Appendix 2: Methods

Table 1 CDC Cytomegalovirus Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Cytomegalovirus (CMV) and Congenital CMV Infection home: https://www.cdc.gov/cytomegalovirus/about/index.html	• Cytomegalovirus (CMV) and Congenital CMV Infection: Clinical Overview: https://www.cdc.gov/cytomegalovirus/hcp/clinical-overview/index.html • Cytomegalovirus (CMV) and Congenital CMV Infection: For Healthcare Providers, Laboratory Testing: https://www.cdc.gov/cytomegalovirus/php/laboratories/index.html	3
Red Book (2021-2024): Report of the Committee on Infectious Diseases (32nd Edition)	• Section 3: Summaries of Infectious Diseases, Cytomegalovirus Infection	1
MMWR	"Cytomegalovirus Infections and Healthcare Providers; Cytomegalovirus and occupational exposure"	3
CDC Resources	• *CDC's Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings* https://www.cdc.gov/infection-control/hcp/core-practices/index.html • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings:* https://www.cdc.gov/infection-control/hcp/isolation-precautions/index.html	2

*** e.g., webpage, article, guideline**

Figure 1 Results of Reference Selection Process: Cytomegalovirus



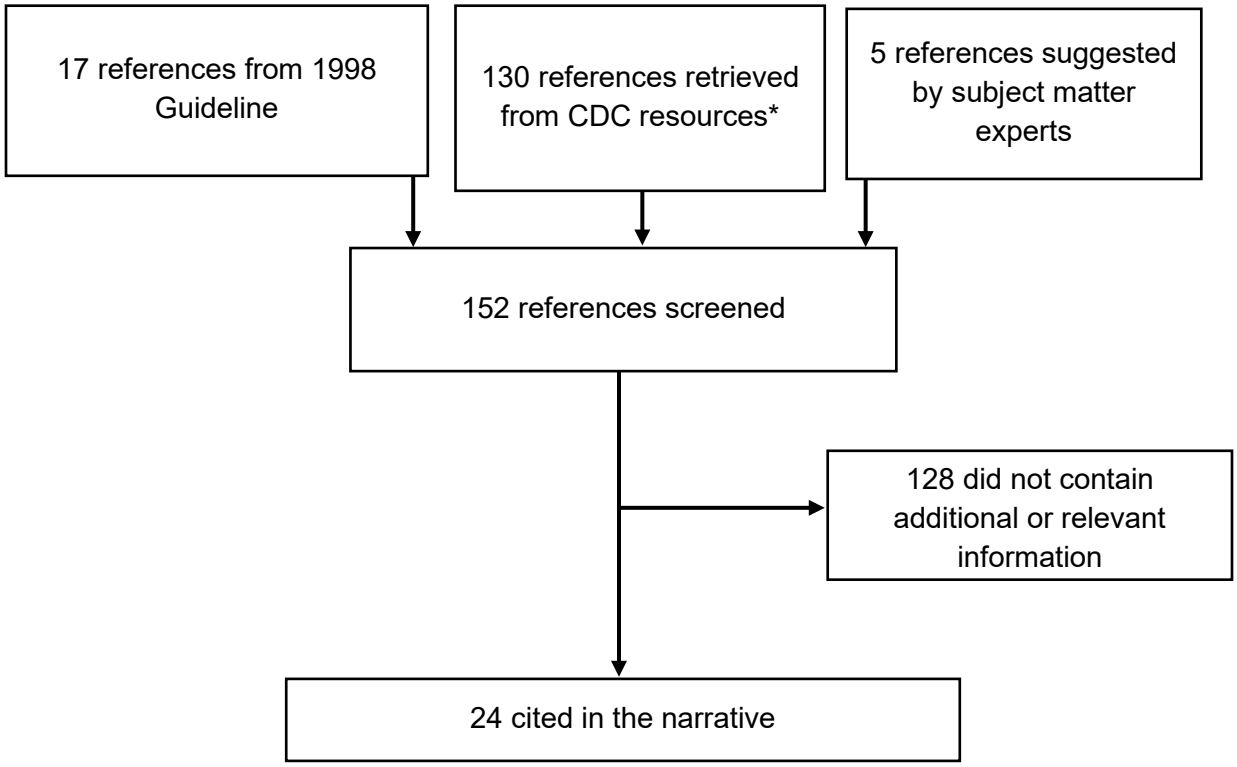
***See Table 1 for details on CDC resources consulted**

Table 2 CDC Diphtheria Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Diphtheria home: https://www.cdc.gov/diphtheria/	• Diphtheria: Clinical Overview. https://www.cdc.gov/diphtheria/hcp/clinical-overview/index.html • Diphtheria: Diphtheria Antitoxin. https://www.cdc.gov/diphtheria/hcp/dat/index.html • Diphtheria: Laboratory. https://www.cdc.gov/diphtheria/php/laboratories/index.html • Information for Close Contacts of a Diphtheria Patient - Worksheet. https://www.cdc.gov/diphtheria/downloads/appendix-2-close-contact-form.pdf	4
ACIP	• Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP). • Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)	16
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 7: Diphtheria	7
Manual for the Surveillance of Vaccine-Preventable Diseases	Chapter 1: Diphtheria	32
MMWR	"toxigenic *Corynebacterium diphtheriae*"	69
CDC Resources	• *Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings* - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings*	2

*** e.g., webpage, article, guideline**

Figure 2 Results of Reference Selection Process: Diphtheria



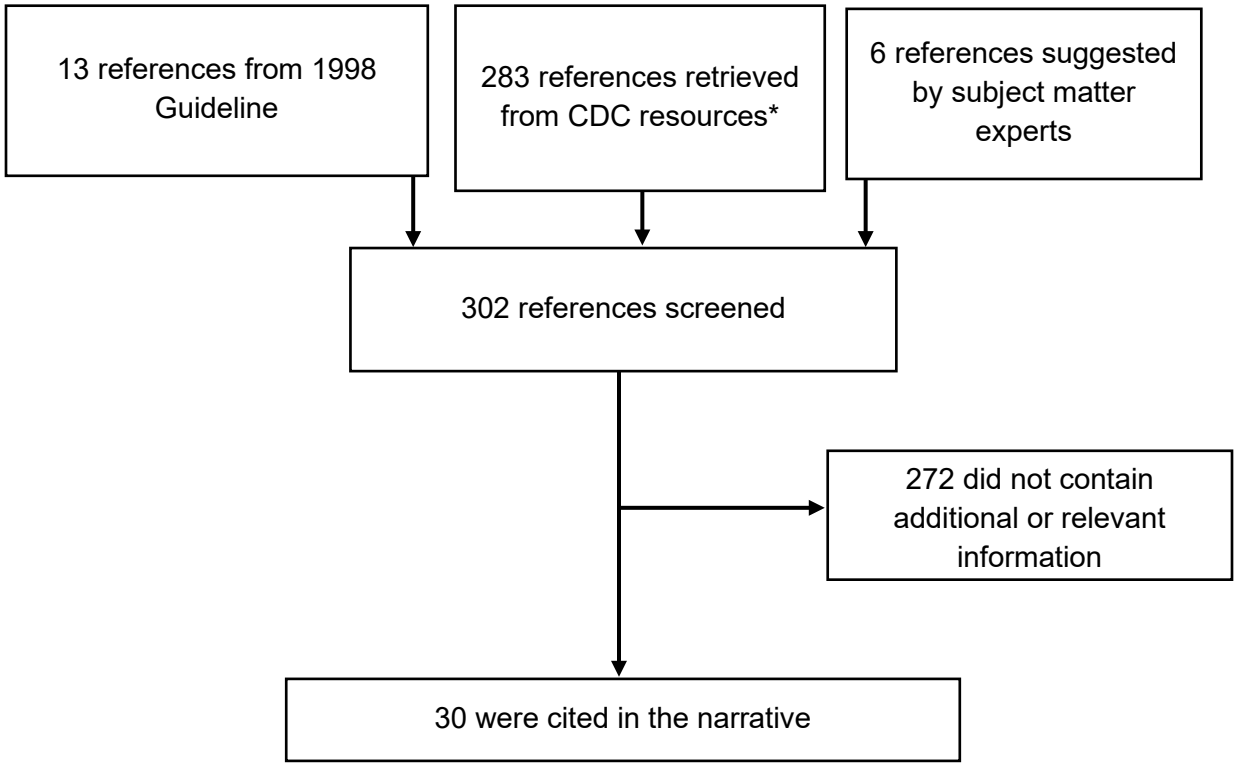
*** Refer to Table 2 for details on CDC resources consulted**

Table 3 CDC Group A Streptococcus Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Streptococcus, group A infection home: https://www.cdc.gov/groupastrep/	• Group A Streptococcal (GAS) Disease: Pharyngitis (Strep Throat). https://www.cdc.gov/group-a-strep/hcp/clinical-guidance/strep-throat.html#cdc_generic_section_6-differential-diagnosis • Group A Streptococcal (GAS) Disease: Necrotizing Fasciitis: All You Need to Know. https://www.cdc.gov/group-a-strep/about/necrotizing-fasciitis.html • Group A Streptococcal (GAS) Disease Publications and Guidelines: Outbreaks. https://www.cdc.gov/group-a-strep/php/public-health-strategy/index.html	3
MMWR	"'group a' *streptococcus* healthcare"	221
CDC Resources	• Prevention of invasive group A streptococcal disease among household contacts of case patients and among postpartum and postsurgical patients: recommendations from the Centers for Disease Control and Prevention • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings*	59

*** e.g., webpage, article, guideline**

Figure 3 Results of Reference Selection Process: Group A Streptococcus



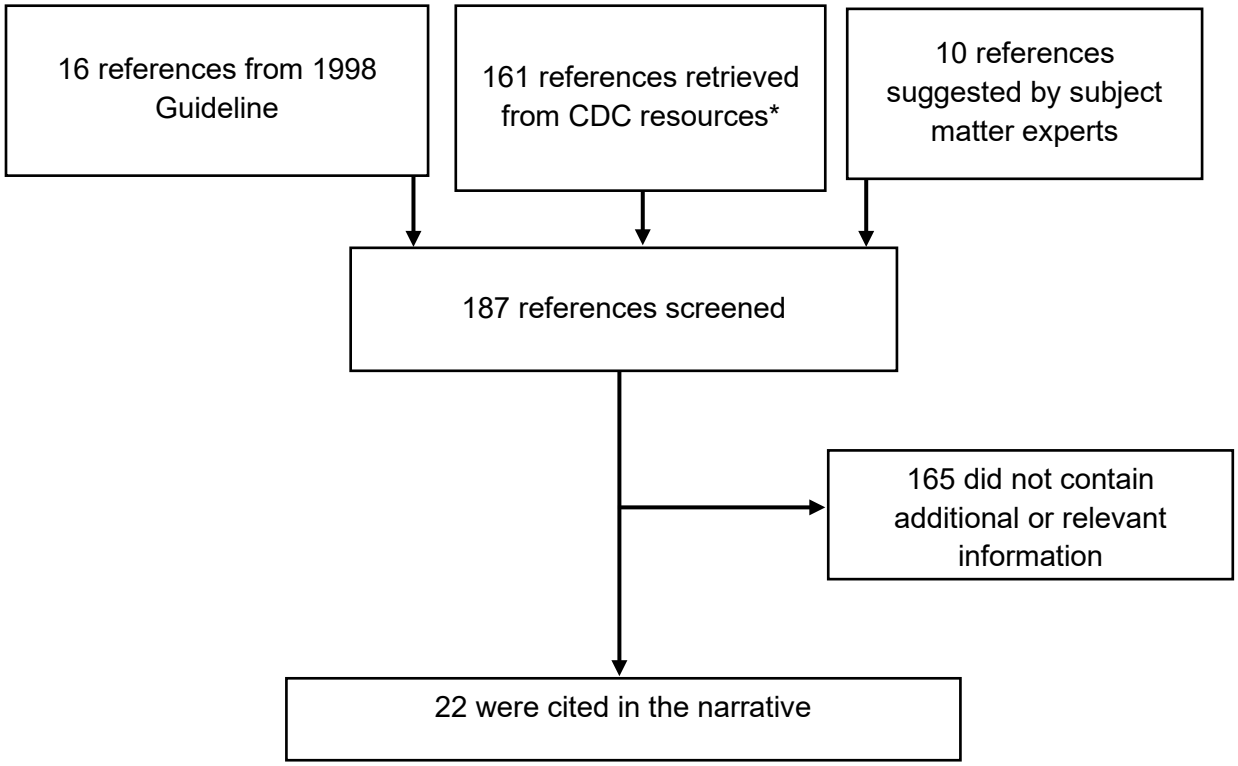
*** Refer to Table 3 for details on CDC resources consulted**

Table 4 CDC Measles Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Measles home: https://www.cdc.gov/measles/index.html	• Measles (Rubeola): For Healthcare Professionals: https://www.cdc.gov/measles/hcp/clinical-overview/index.html	4
ACIP	• Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: summary recommendations of the Advisory Committee on Immunization Practices (ACIP) • MMR Advisory Committee on Immunization Practices (ACIP) Vaccine Recommendations (Measles, Mumps and Rubella) • Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)	12
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 13: Measles	21
Manual for the Surveillance of Vaccine-Preventable Diseases	Chapter 7: Measles	46
MMWR	"measles, rubeola"	75
CDC Resources	• *CDC's Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings 2022)* • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007)* • Interim Infection Prevention and Control Recommendations for Measles in Healthcare Settings: https://www.cdc.gov/infection-control/hcp/measles/index.html	3

*** e.g., webpage, article, guideline**

Figure 4 Results of Reference Selection Process: Measles



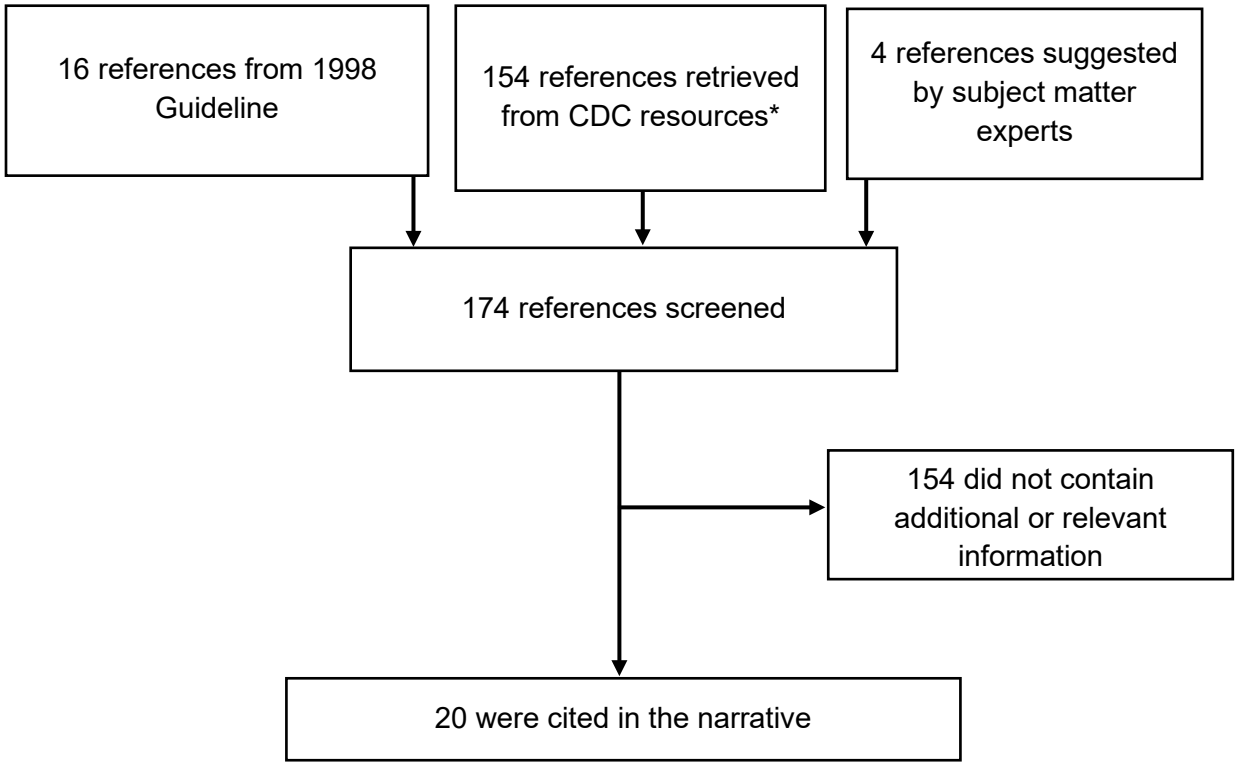
*** Refer to Table 4 for details on CDC resources consulted**

Table 5 CDC Meningococcal Disease Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Meningococcal Disease home: https://www.cdc.gov/meningococcal/index.html	• Meningococcal Disease: Technical and Clinical Information. https://www.cdc.gov/meningococcal/hcp/clinical/index.html • Guidance for the Evaluation and Public Health Management of Suspected Outbreaks of Meningococcal Disease https://www.cdc.gov/meningococcal/downloads/meningococcal-outbreak-guidance.pdf • Meningitis: Laboratory Methods for the Diagnosis of Meningitis Caused by *Neisseria meningitidis*, *Streptococcus pneumoniae*, and *Haemophilus influenzae* https://iris.who.int/handle/10665/70765	3
ACIP	• Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP) • Prevention and control of meningococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP) • Updated Recommendations for Use of MenB-FHbp Serogroup B Meningococcal Vaccine - Advisory Committee on Immunization Practices	3
Epidemiology and Prevention of Vaccine-Preventable Diseases ("Pink Book")	Chapter 14: Meningococcal Disease	12
Manual for the Surveillance of Vaccine-Preventable Diseases	• Chapter 8: Meningococcal Disease • Vaccines and Preventable Diseases: Meningococcal: Who Needs to Be Vaccinated? https://www.cdc.gov/vaccines/vpd/mening/hcp/who-vaccinate-hcp.html	37
MMWR	"*Neisseria meningitidis* healthcare"	96
CDC Resources	• *Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings* - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings* • *Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition*	3

*** e.g., webpage, article, guideline**

Figure 5 Results of Reference Selection Process: Meningococcal Disease



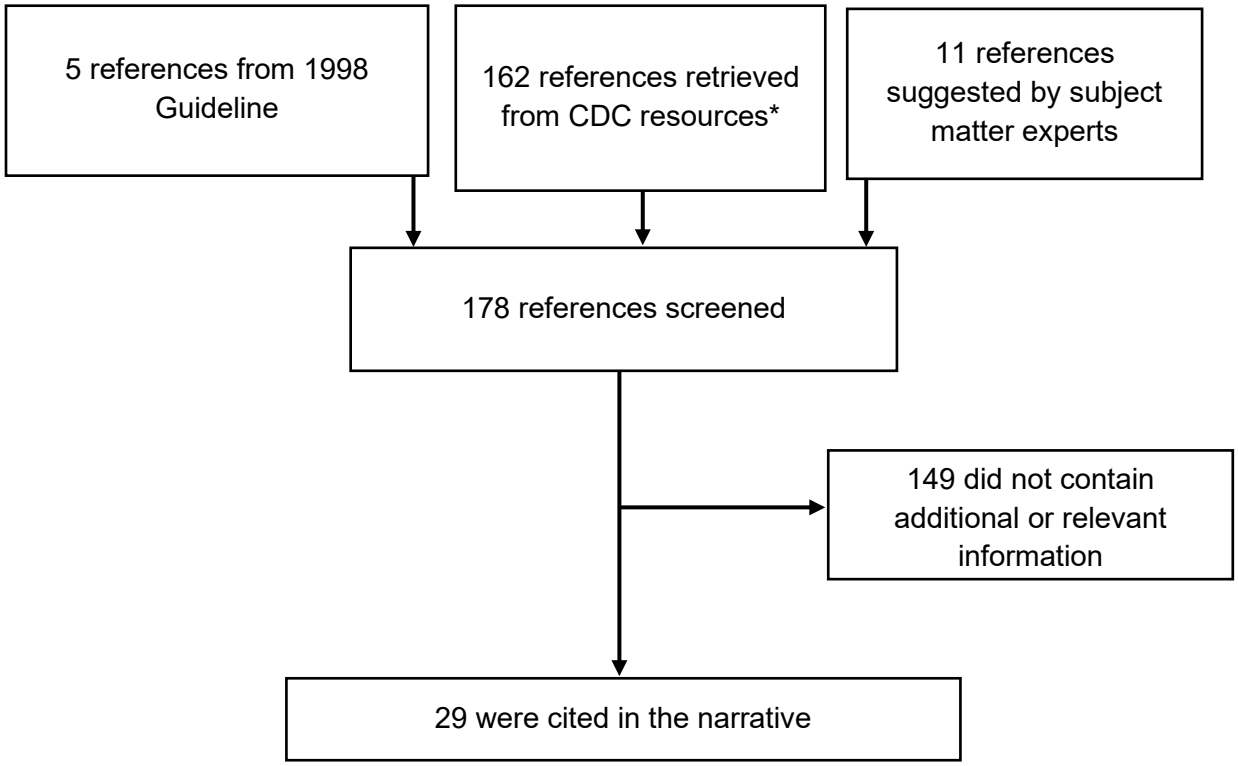
*** Refer to Table 5 for details on CDC resources consulted**

Table 6 CDC Mumps Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Mumps home: https://www.cdc.gov/mumps/index.html	• Mumps: Clinical Overview: https://www.cdc.gov/mumps/hcp/clinical-overview/index.html • Mumps: For Healthcare Providers: Complications: https://www.cdc.gov/mumps/hcp/clinical-signs/index.html#cdc_hcp_clinical_complications-complications • Mumps: Laboratory Testing for Mumps Infection: https://www.cdc.gov/mumps/hcp/clinical-signs/index.html#cdc_hcp_clinical_laboratory_samples-laboratory-testing • Mumps: Mumps Cases and Outbreaks: https://www.cdc.gov/mumps/outbreaks/index.html • Mumps: Strategies for the Control and Investigation of Mumps Outbreaks: https://www.cdc.gov/mumps/php/public-health-strategy/index.html • Mumps: Strategies for the Control and Investigation of Mumps Outbreaks: Recommend a third dose of MMR vaccine for groups at increased risk: https://www.cdc.gov/mumps/php/public-health-strategy/index.html#cdc_public_health_strategy_planning_and_prevention-prevention-strategies • Mumps: Strategies for the Control and Investigation of Mumps Outbreaks: Setting-specific guidance and resources: https://www.cdc.gov/mumps/php/public-health-strategy/index.html#cdc_public_health_strategy_implementation-setting-specific-prevention-guidance • Mumps: Strategies for the Control and Investigation of Mumps Outbreaks: Identify: https://www.cdc.gov/mumps/php/public-health-strategy/index.html#cdc_public_health_strategy_recommendations-investigation-identification	8
ACIP	• Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: summary recommendations of the Advisory Committee on Immunization Practices (ACIP) • MMR Advisory Committee on Immunization Practices (ACIP) Vaccine Recommendations (Measles, Mumps and Rubella) • Recommendation of the Advisory Committee on Immunization Practices for Use of a Third Dose of Mumps Virus-Containing Vaccine in Persons at Increased Risk for Mumps During an Outbreak • Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)	21
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 15: Mumps	13
Manual for the Surveillance of Vaccine-Preventable Diseases	Chapter 9: Mumps Chapter 22: Laboratory Support for Surveillance of Vaccine-Preventable Diseases	83
MMWR	"mumps"	35
CDC Resources	• *CDC's Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings (2022)* • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007)*	2

*** e.g., webpage, article, guideline**

Figure 6 Results of Reference Selection Process: Mumps



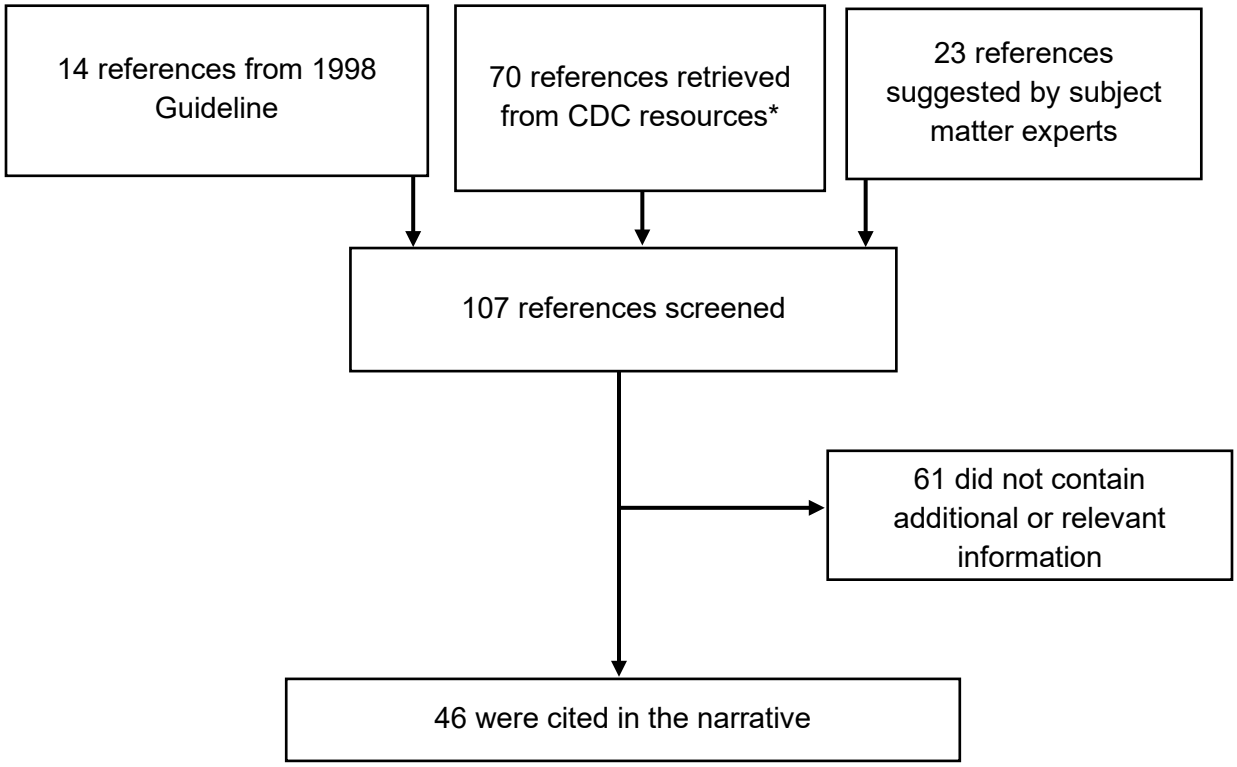
*** Refer to Table 6 for details on CDC resources consulted**

Table 7 CDC Pertussis Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Pertussis home: https://www.cdc.gov/pertussis/	• Pertussis (Whooping Cough): Clinical Overview https://www.cdc.gov/pertussis/hcp/clinical-overview/index.html • Pertussis (Whooping Cough): Clinical Features. https://www.cdc.gov/pertussis/hcp/clinical-signs/index.html • Pertussis (Whooping Cough): About Pertussis Outbreaks. https://www.cdc.gov/pertussis/outbreaks/index.html • Pertussis (Whooping Cough): Postexposure Antimicrobial Prophylaxis. https://www.cdc.gov/pertussis/php/postexposure-prophylaxis/index.html • Pertussis (Whooping Cough): Diagnostic Testing https://www.cdc.gov/pertussis/php/laboratories/index.html	5
ACIP	• Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP) • Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP).	22
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 16: Pertussis	7
Manual for the Surveillance of Vaccine-Preventable Diseases	• Chapter 10: Pertussis • Evaluating Revaccination of Healthcare Personnel with Tdap: Factors to Consider https://www.cdc.gov/pertussis/hcp/vaccine-recommendations/index.html#cdc_generic_section_5-adults.	33
CDC Resources	• *Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings* - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings* • Recommended antimicrobial agents for the treatment and postexposure prophylaxis of pertussis: 2005 CDC Guidelines https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5414a1.htm	3

*** e.g., webpage, article, guideline**

Figure 7 Results of Reference Selection Process: Pertussis



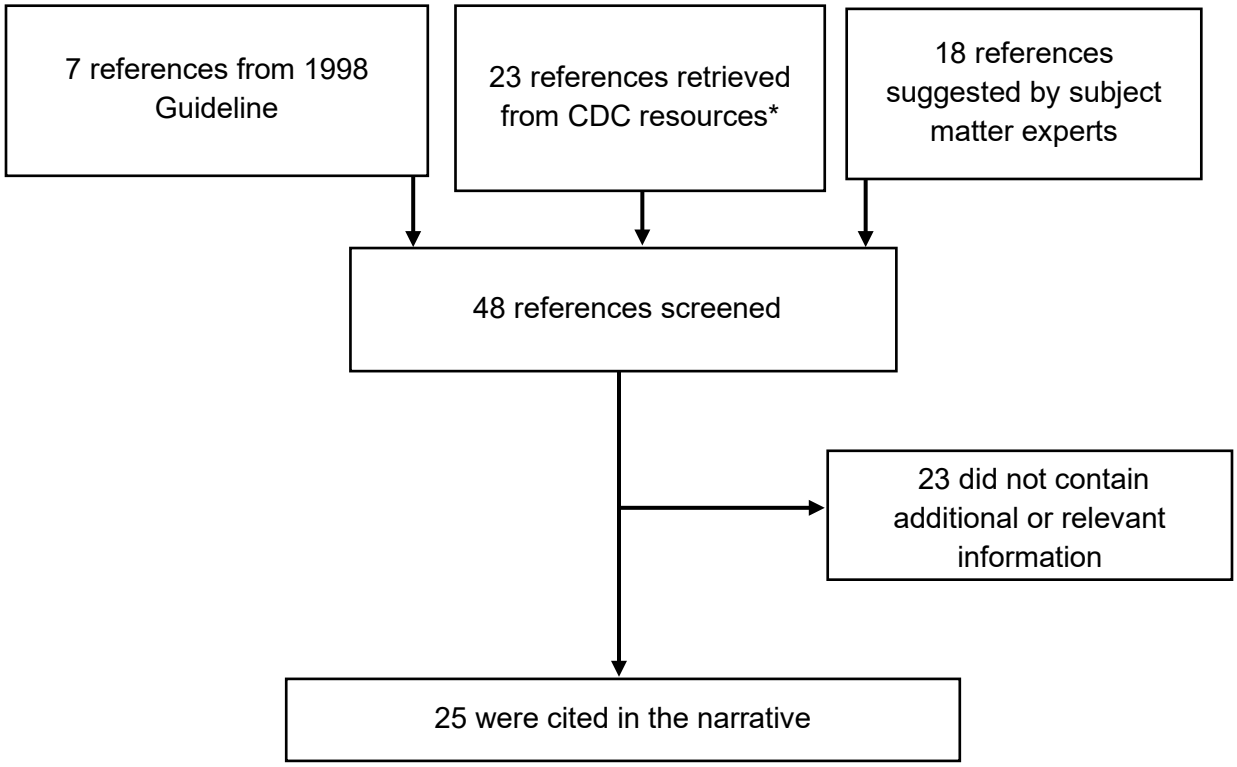
*** Refer to Table 7 for details on CDC resources consulted**

Table 8 CDC Rabies Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Rabies home: https://www.cdc.gov/rabies/index.html	• Rabies: Exposure https://www.cdc.gov/rabies/when-to-seek-care/index.html • Rabies: Diagnosis in Animals and Humans https://www.cdc.gov/rabies/hcp/clinical-overview/index.html • Rabies: Preexposure Vaccinations https://www.cdc.gov/rabies/hcp/prevention-recommendations/pre-exposure-prophylaxis.html • Rabies: Transmission https://www.cdc.gov/rabies/hcp/clinical-overview/index.html#cdc_clinical_overview_how_spread-how-it-spreads • Rabies: Signs and Symptoms https://www.cdc.gov/rabies/hcp/clinical-overview/index.html#cdc_clinical_overview_clin_fea-signs-and-symptoms • Rabies: State and Local Rabies Consultation Resources https://www.cdc.gov/public-health-gateway/php/communications-resources/health-department-directories.html • Rabies: Information for Healthcare Providers https://www.cdc.gov/rabies/site.html#hcp	12
ACIP	• Use of a Reduced (4-Dose) Vaccine Schedule for Postexposure Prophylaxis to Prevent Human Rabies	1
MMWR	"Rabies virus"	28
HICPAC Resources	• *Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings* - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings* • *Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition*	3

*** e.g., webpage, article, guideline**

Figure 8 Results of Reference Selection Process: Rabies



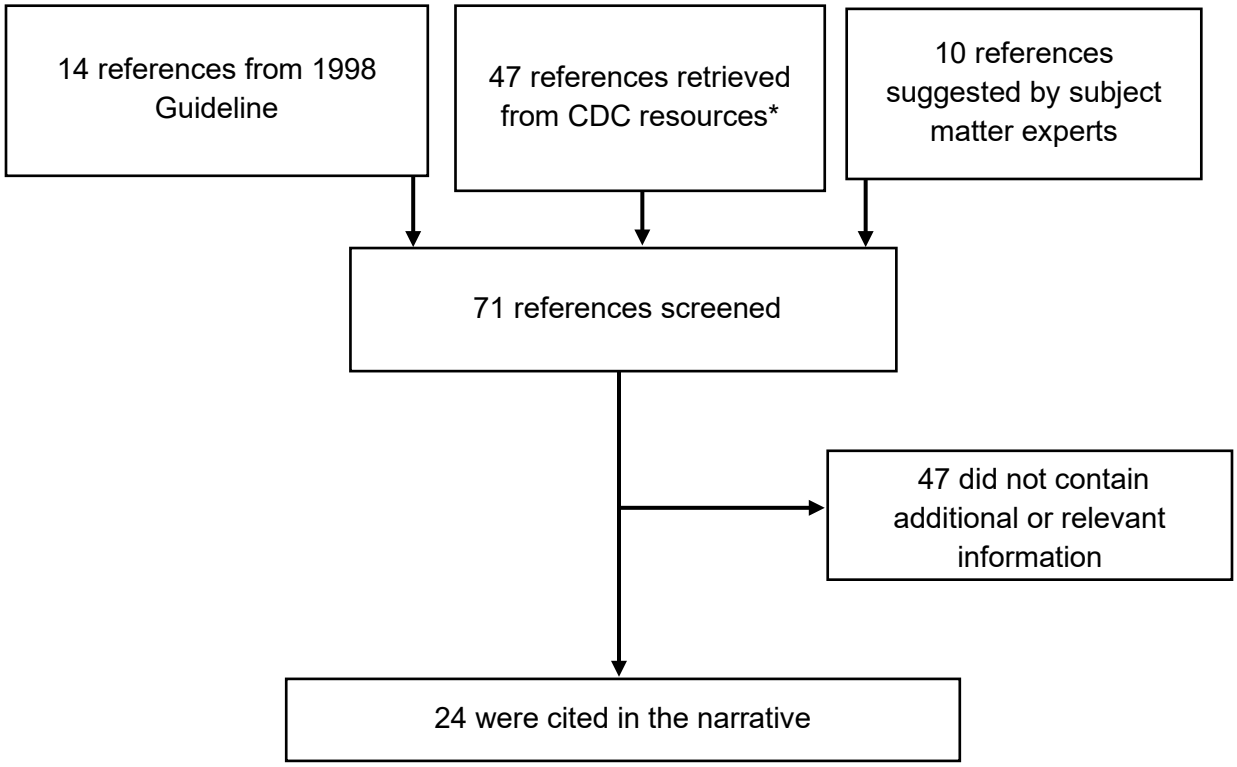
*** Refer to Table 8 for details on CDC resources consulted**

Table 9 CDC Rubella Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Rubella home: https://www.cdc.gov/rubella/index.html	• Rubella: For healthcare professionals: https://www.cdc.gov/rubella/hcp/clinical-overview/index.html	3
ACIP	• Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: summary recommendations of the Advisory Committee on Immunization Practices (ACIP) • MMR Advisory Committee on Immunization Practices (ACIP) Vaccine Recommendations (Measles, Mumps and Rubella) • Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)	3
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 20: Rubella	16
Manual for the Surveillance of Vaccine-Preventable Diseases	Chapter 14: Rubella	17
MMWR	"rubella, German measles, three-day measles"	6
CDC Resources	• *CDC's Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings (2022)* • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007)*	2

*** e.g., webpage, article, guideline**

Figure 9 Results of Reference Selection Process: Rubella



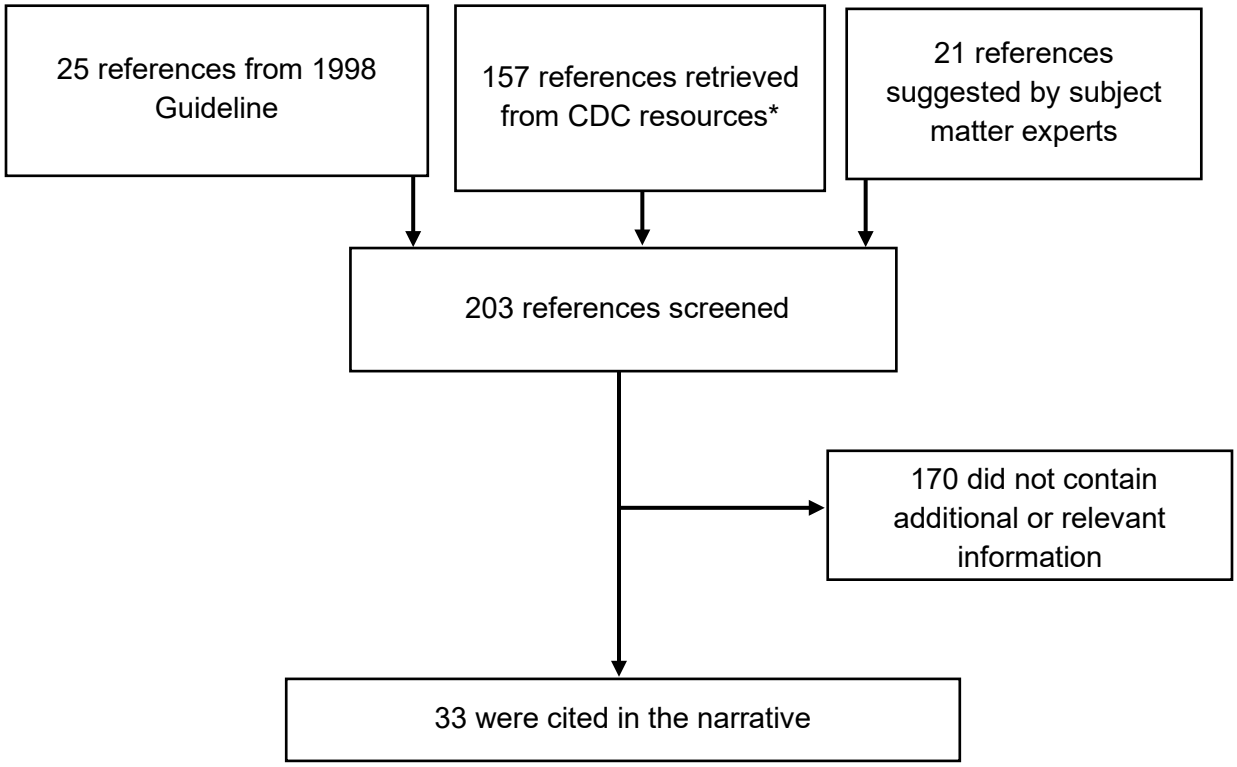
*** Refer to Table 9 for details on CDC resources consulted**

Table 10 CDC Varicella-Zoster Virus Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Varicella home: https://www.cdc.gov/chickenpox/index.html Herpes Zoster home: https://www.cdc.gov/shingles/index.html	• Chickenpox (Varicella): For Healthcare Professionals: https://www.cdc.gov/chickenpox/hcp/clinical-overview/index.html • Chickenpox (Varicella): Laboratory Testing for VZV: https://www.cdc.gov/chickenpox/php/laboratories/index.html • Chickenpox (Varicella) for Healthcare Professionals: Clinical Features: https://www.cdc.gov/chickenpox/hcp/clinical-overview/index.html#cdc_clinical_overview_clin_fea-clinical-features • Chickenpox (Varicella) for Healthcare Professionals: People at High Risk for Severe Varicella: https://www.cdc.gov/chickenpox/hcp/clinical-guidance/index.html • Shingles (Herpes Zoster) for Healthcare Professionals: Preventing Varicella-Zoster Virus (VZV) Transmission from Zoster in Healthcare Settings: https://www.cdc.gov/shingles/hcp/infection-control/index.html • Shingles (Herpes Zoster): Transmission: https://www.cdc.gov/shingles/hcp/clinical-overview/index.html#cdc_clinical_overview_how_spread-how-it-spreads • Shingles (Herpes Zoster) for Healthcare Professionals: Diagnosis & Testing: https://www.cdc.gov/shingles/hcp/clinical-overview/index.html#cdc_clinical_overview_test_dia-testing • Shingles (Herpes Zoster) for Healthcare Professionals: Clinical Overview: https://www.cdc.gov/shingles/hcp/clinical-overview/index.html	8
ACIP	• Varicella ACIP Vaccine Recommendations: Advisory Committee on Immunization Practices (ACIP) • Zoster (Shingles) ACIP Vaccine Recommendations: Advisory Committee on Immunization Practices (ACIP) • Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)	17
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 22: Varicella Chapter 23: Zoster	34
Manual for the Surveillance of Vaccine-Preventable Diseases	Chapter 17: Varicella Chapter 22: Laboratory Support for Surveillance of Vaccine-Preventable Diseases	87
MMWR	"varicella-zoster, herpes zoster, varicella, chickenpox, shingles"	9
CDC Resources	• *CDC's Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings (2022)* • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007)*	2

*** e.g., webpage, article, guideline**

Figure 10 Results of Reference Selection Process: Varicella- Zoster Virus



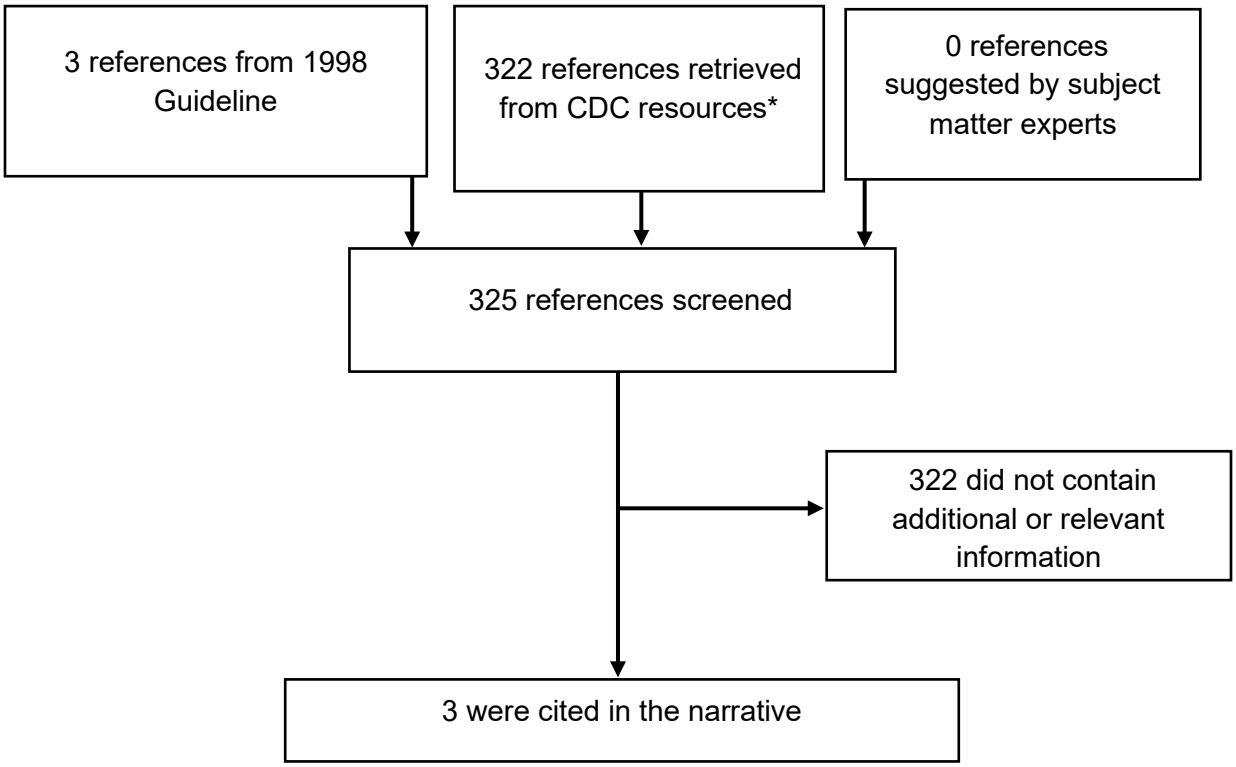
*** Refer to Table 10 for details on CDC resources consulted**

Table 11 CDC Pregnant Healthcare Personnel Resources Consulted

Source	Website browsed or keyword(s) used	Results*
Pregnancy home: https://www.cdc.gov/pregnancy/	• Pregnancy and Vaccination: https://www.cdc.gov/vaccine-safety/about/pregnancy.html	2
ACIP	• Advisory Committee on Immunization Practices: Guidance for Vaccine Recommendations for Pregnant and Breastfeeding Women • Vaccine Recommendations and Guidelines of the ACIP: Special Situations	2
Epidemiology and Prevention of Vaccine-Preventable Diseases. ("Pink Book")	Chapter 2: General Recommendations on Immunization: Contraindications	1
Manual for the Surveillance of Vaccine-Preventable Diseases	Chapter 3: Hepatitis A Chapter 4: Hepatitis B Chapter 7: Measles Chapter 9: Mumps Chapter 14: Rubella Chapter 17: Varicella	311
MMWR	"infection control pregnant healthcare personnel"	3
CDC Resources	• *Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings* - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC) • *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings (2007)* • *Infection Control in Healthcare Personnel: Infrastructure and Routine Practices for Occupational Infection Prevention and Control Services*	3

*** e.g., webpage, article, guideline**

Figure 11 Results of Reference Selection Process: Pregnant Healthcare Personnel



*** Refer to Table 11 for details on CDC resources consulted**

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Declarations of Interest

None of the Workgroup members reported financial or intellectual interests related to the topics in this review except for the following:

- Hilary Babcock: Society for Healthcare Epidemiology of America liaison to HICPAC.
- Ruth Carrico: Speaker and consultant for Pfizer; speaker for Sanofi Pasteur; consultant for Medscape; speaker and workgroup member of the Gerontological Society iCAMP workshop committee; recipient of research award from Pfizer and research subaward from CDC (via Catholic Charities).
- Colleen Kraft: Scientific advisor for Seres Therapeutics; consultant for Rebiotix, Inc.; and will participate on a scientific advisory board for Adventa Bioscience.
- Mark Russi: American College of Occupational and Environmental Medicine (ACOEM) liaison to HICPAC.
- Connie Steed: Consultant for Global Life Technologies, which includes education.
- Thomas R. Talbot: Spouse receives research support from Sanofi Pasteur, Medimmune, and Gilead and serves on advisory committee for Novartis.
- David J. Weber: Consultant and speaker for Pfizer and Merck.