



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

**Diphtheria, Group A Streptococcus, Meningococcal Disease, Pertussis,  
and Rabies Sections**

**Centers for Disease Control and Prevention  
National Center for Emerging and Zoonotic Infectious Diseases  
Division of Healthcare Quality Promotion**

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## Executive Summary

This document, *Infection Control in Healthcare Personnel: Epidemiology and Control of Selected Infections Transmitted Among Healthcare Personnel and Patients*, supersedes the following 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*: “4. Diphtheria;” “9. Meningococcal Disease;” “12. Pertussis;” “14. Rabies;” and “18. *Streptococcus*, group A infection.” 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*<sup>1</sup> (“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 the following 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: “Diphtheria,” “Meningococcal Disease,” “Pertussis,” “*Streptococcus*, group A infection,” and “Rabies.”

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.<sup>2-5</sup>

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 1-5). 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 1-5). Recommendations and supporting narratives were presented at public HICPAC meetings for review, input, and approval.

Updated recommendations and accompanying narratives for the Diphtheria, Meningococcal Disease, Pertussis, group A *Streptococcus*, and Rabies sections were presented at [HICPAC meetings](#) (<https://www.cdc.gov/hicpac/minutes.html>) in November 2017, February 2018, August 2018, November 2018, May 2019, and August 2021.<sup>6</sup> 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/infectioncontrol/guidelines/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.<sup>7</sup>

### **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/infectioncontrol/guidelines/healthcare-personnel/index.html) (<https://www.cdc.gov/infectioncontrol/guidelines/healthcare-personnel/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)) (<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.<sup>8</sup>



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<sup>3</sup>, 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.<sup>9</sup> Ultimately, the degree of immunocompromise for HCP is determined by the treating provider, and preventive actions are tailored to each individual and situation.

### **Pregnant HCP**

Pregnant HCP are temporarily immunocompromised, and occupational acquisition of infections is of special concern to female HCP of childbearing age and 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.<sup>10</sup>

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 a pregnant woman 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., HBIV, VariZig) may be administered, if indicated, to pregnant women. Further, Tdap and influenza vaccines are specifically indicated for pregnant women.<sup>11</sup> Counselling of pregnant HCP remains paramount for safety in the workplace and disease-specific recommendations for pregnant HCP are provided when appropriate in individual sections of this update.

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

## **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.<sup>1-5</sup> 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.<sup>2,6,7</sup> 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.<sup>2,6,8,9</sup>

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

- a. encouraging vaccination of HCP against diphtheria in compliance with routine adult vaccine schedules<sup>10,11</sup>;

- 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<sup>12</sup>;
- 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 [DTaP/Tdap/Td ACIP Vaccine Recommendations](https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/dtap.html) (<https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/dtap.html>).<sup>13</sup>

### 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.<sup>2</sup> 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.<sup>14</sup> 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.<sup>14,15</sup>

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

Initial symptoms of respiratory diphtheria include sore throat, difficulty in swallowing, malaise, and low-grade fever.<sup>2,14</sup> 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.<sup>2,16</sup> The pseudomembrane is firmly adherent to the tissue, and forcible attempts to remove it cause bleeding.<sup>14</sup> Cutaneous diphtheria may be characterized by a scaling rash or by ulcers with clearly demarcated edges.<sup>14</sup>

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.<sup>14,16</sup>

Treatment for diphtheria is begun at the first sign(s) of clinical illness.<sup>1,14,17</sup>

## 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.<sup>2</sup> Information regarding diphtheria testing is available on the [CDC Diphtheria: Laboratory website](https://www.cdc.gov/diphtheria/laboratory.html) (<https://www.cdc.gov/diphtheria/laboratory.html>).<sup>18</sup>

## 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.<sup>1,19,20</sup> 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/close-contacts.pdf) (<https://www.cdc.gov/diphtheria/downloads/close-contacts.pdf>).<sup>19</sup>

Administration of PEP or treatment for diphtheria does not always eliminate the carrier state.<sup>21-24</sup> 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/close-contacts.pdf) (<https://www.cdc.gov/diphtheria/downloads/close-contacts.pdf>) provides additional information on the management of toxin-producing *C. diphtheriae* carriers.<sup>15,19</sup> 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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***Infection Control in Healthcare Personnel: Epidemiology and Control of Selected Infections Transmitted Among Healthcare Personnel and Patients***

**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.<sup>1</sup> Healthcare-associated transmission of GAS has been documented from patients to healthcare personnel (HCP) and from HCP to patients.<sup>1-10</sup>

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<sup>11</sup>;
- 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 personnel.<sup>1,9,12-22</sup>

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.<sup>2,3,10,23,24</sup>

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.<sup>25,26</sup>

### **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.<sup>25</sup> GAS pharyngitis is typically not associated with cough, rhinorrhea, hoarseness, or conjunctivitis – symptoms more frequently associated with viral pharyngitis.<sup>25</sup> 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.<sup>27</sup>

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.<sup>28</sup> The portal of entry is unknown in most invasive GAS infections, but is presumed to be skin or mucous membranes.<sup>29</sup> 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.<sup>30</sup>

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.<sup>29</sup> STSS can occur without an identifiable focus of infection, although the presence of concomitant local soft tissue infection is common.<sup>29</sup>

The incubation period of GAS pharyngitis is approximately 2 to 5 days.<sup>25</sup> 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.<sup>29</sup>

### **Testing and Diagnosis**

Because the signs and symptoms of GAS pharyngitis are similar to other infections, laboratory testing is necessary to confirm the diagnosis.<sup>25,27</sup> 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.<sup>25,27</sup>

Invasive GAS disease is usually confirmed by isolation of GAS from a normally sterile body site through culture.<sup>14</sup>

### 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.<sup>14</sup> CDC maintains [recommendations for screening HCP during GAS outbreaks in healthcare settings](https://academic.oup.com/cid/article/35/8/950/330363) (<https://academic.oup.com/cid/article/35/8/950/330363>), including which HCP to select for screening and which body sites to culture.<sup>14</sup> When screening of HCP is performed, sites from which specimens are obtained and cultured include the throat, anus, vagina, and any skin lesions.<sup>14</sup>

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) (<https://academic.oup.com/cid/article/35/8/950/330363>).<sup>14</sup>

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

**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*.<sup>1-4</sup>

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<sup>5</sup>;
- 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.<sup>3,5,6</sup>

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) (https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6007a1.htm).<sup>3,7</sup> Vaccination is recommended for HCP who are employed as microbiologists who are exposed routinely to isolates of *N. meningitidis*.<sup>3,8-10</sup> 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) (https://www.cdc.gov/vaccines/vpd/mening/hcp/who-vaccinate-hcp.html).<sup>9</sup>

**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.<sup>11,12</sup> 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).<sup>3,6,12,13</sup>

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.<sup>14</sup> 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 \(BMBL\), 5<sup>th</sup> Edition](https://www.cdc.gov/biosafety/publications/bmb15/index.htm) (<https://www.cdc.gov/biosafety/publications/bmb15/index.htm>).<sup>10</sup>

### 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.<sup>12</sup> Without prompt and appropriate treatment, the infection can progress rapidly and result in death.<sup>12</sup>

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.<sup>11-13</sup> Persons who have close contact with persons with invasive disease are at substantially increased risk for acquiring carriage and disease.<sup>12</sup>

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.<sup>12,13</sup> 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.<sup>11</sup> 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.<sup>11,12,15</sup>

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.<sup>12</sup> 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).<sup>16</sup> 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.<sup>12</sup>

Additional information on laboratory testing for *N. meningitidis* is available on the [CDC Laboratory Methods for the Diagnosis of Meningitis website](https://www.cdc.gov/meningitis/lab-manual/index.html) (<https://www.cdc.gov/meningitis/lab-manual/index.html>).<sup>17</sup>

### Postexposure Prophylaxis

Chemoprophylaxis is administered as soon as possible after exposure, ideally less than 24 hours after identification of an index patient.<sup>13</sup> Chemoprophylaxis administered more than 14 days after onset of illness in an index patient is probably of limited or no value.<sup>12,13</sup> 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.<sup>13,18</sup> 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.<sup>12,19,20</sup> 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/vaccines/pubs/surv-manual/chpt08-mening.html) (<https://www.cdc.gov/vaccines/pubs/surv-manual/chpt08-mening.html>).<sup>12</sup>

## 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) (<https://www.cdc.gov/meningococcal/downloads/meningococcal-outbreak-guidance.pdf>).<sup>16</sup>

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

### **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.<sup>1-12</sup> Serologic studies of HCP suggest that they may be infected with pertussis much more frequently than indicated by attack rates of clinical disease.<sup>13,14</sup>

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<sup>13,15</sup>;
- b. in addition to using Standard Precautions, placing patients with known or suspected pertussis in Droplet Precautions<sup>16</sup>;
- 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.<sup>5,13</sup>

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>).<sup>13,17,18</sup> 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) (<https://www.cdc.gov/vaccines/vpd/pertussis/tdap-revac-hcp.html>).<sup>17</sup>

### 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.<sup>13</sup> 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.<sup>19,20</sup> The incubation period is usually 5 to 10 days, but symptoms may develop up to 3 weeks after exposure.<sup>21</sup> 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).<sup>22</sup>

Symptomatic persons who receive effective antimicrobial therapy for pertussis are no longer contagious after 5 days of appropriate treatment.<sup>13,23</sup>

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.<sup>21</sup> 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.<sup>21</sup>

### 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.<sup>24,25</sup> More detailed information regarding testing persons for pertussis is available on the CDC [Pertussis \(Whooping Cough\) Diagnostic Testing website](https://www.cdc.gov/pertussis/clinical/diagnostic-testing/index.html) (<https://www.cdc.gov/pertussis/clinical/diagnostic-testing/index.html>).<sup>26</sup>

Other *Bordetella* species (e.g., *B. parapertussis*, *B. holmesii*) may be detected and can occur alone or simultaneously with *B. pertussis* infection.<sup>27-31</sup> 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.<sup>27,28,32,33</sup> One report from 1971 estimated that 3-4% of patients with parapertussis develop clinical disease, compared to 75% with pertussis.<sup>33</sup> The severity of parapertussis illness among special populations, such as infants and immunocompromised persons, is unclear, with few hospitalizations and related deaths reported.<sup>34-39</sup> 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.<sup>25,40</sup>

### 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.<sup>13,17,18</sup> 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.<sup>5,13,41-43</sup> The preferred agents for postexposure prophylaxis are azithromycin, erythromycin, and clarithromycin.<sup>44</sup> 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) (<https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5414a1.htm>).<sup>44</sup>

### 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/about.html) (<https://www.cdc.gov/pertussis/outbreaks/about.html>).<sup>45</sup>

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

**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.<sup>1</sup> Person to person transmission of rabies is rare and has been reported almost exclusively via cornea, tissue, and organ transplantation.<sup>2,3-7</sup>

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) (<https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5703a1.htm>), with updates posted on the [ACIP Vaccine Recommendations and Schedules | CDC](https://www.cdc.gov/vaccines/acip/recommendations.html) website (<https://www.cdc.gov/vaccines/acip/recommendations.html>).<sup>8</sup> Additional information regarding preexposure rabies vaccination is available on the [CDC Rabies Preexposure Vaccinations](https://www.cdc.gov/rabies/specific_groups/travelers/pre-exposure_vaccinations.html) website ([https://www.cdc.gov/rabies/specific\\_groups/travelers/pre-exposure\\_vaccinations.html](https://www.cdc.gov/rabies/specific_groups/travelers/pre-exposure_vaccinations.html)).<sup>9</sup>

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.<sup>10</sup> 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.<sup>11</sup>

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) (https://wwwnc.cdc.gov/travel/yellowbook/2020/travel-related-infectious-diseases/rabies)<sup>12</sup> 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.<sup>8</sup>

Laboratory safety, exposures to rabies, and prevention in laboratory settings are described in [Biosafety in Microbiological and Biomedical Laboratories \(BMBL\), 6<sup>th</sup> Edition](https://www.cdc.gov/biosafety/publications/bmb15/index.htm) (https://www.cdc.gov/biosafety/publications/bmb15/index.htm).<sup>13</sup>

### 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.<sup>14,15</sup>

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.<sup>14</sup> 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.<sup>14</sup> In humans, the incubation period averages 1 to 3 months but ranges from days to years.<sup>16,17</sup>

### 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.<sup>18</sup>

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.<sup>19</sup> 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](https://www.cdc.gov/rabies/index.html) website (<https://www.cdc.gov/rabies/index.html>).<sup>20</sup>

### 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) (<http://www.nasphv.org/Documents/StatePublicHealthVeterinariansByState.pdf>).<sup>21</sup>

HCP who report an exposure to rabies may be offered PEP depending on the nature of the exposure.<sup>16</sup> In addition to PEP, all affected wounds should be washed promptly to reduce the amount of virus that may remain present in the wound.<sup>8,16</sup> 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](https://www.cdc.gov/rabies/medical_care/vaccine.html) website ([https://www.cdc.gov/rabies/medical\\_care/vaccine.html](https://www.cdc.gov/rabies/medical_care/vaccine.html)).<sup>22-25</sup>

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## Appendix 1: Abbreviations and Acronyms

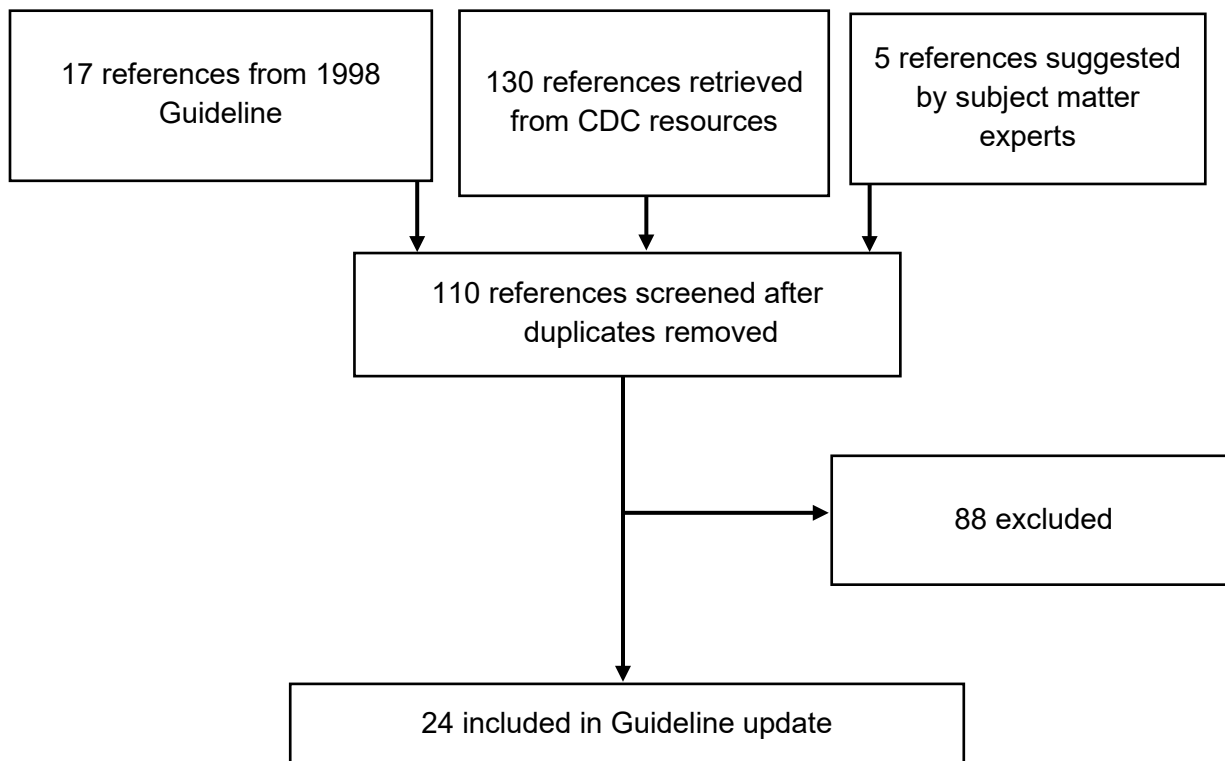
Acronym	Expansion
ACIP	Advisory Committee on Immunization Practices
ACOEM	American College of Occupational and Environmental Medicine
<i>B. pertussis</i>	<i>Bordetella pertussis</i>
BMBL	Biosafety in Microbiological and Biomedical Laboratories
CDC	Centers for Disease Control and Prevention
CLIA	Clinical Laboratory Improvement Amendments
DHQP	Division of Healthcare Quality Promotion
CSF	Cerebrospinal Fluid
FMLA	Family and Medical Leave Act of 1993
GAS	Group A <i>Streptococcus</i>
HCO	Healthcare Organization
HCP	Healthcare Personnel
HICPAC	Healthcare Infection Control Practices Advisory Committee
HIV	Human Immunodeficiency Virus
IDSA	Infectious Diseases Society of America
IPC	Infection Prevention and Control
IV	Intravenous
LP	Lumbar Puncture
<i>N. meningitidis</i>	<i>Neisseria meningitidis</i>
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
RT	Reverse Transcription
SHEA	Society for Healthcare Epidemiology of America
STSS	Streptococcal Toxic-Shock Syndrome
TB	Tuberculosis
Tdap	Tetanus, Diphtheria, Pertussis
TMP-SMZ	Trimethoprim-sulfamethoxazole

## Appendix 2: Methods

Table 1 CDC Diphtheria Resources Consulted

Source	Website browsed or keyword(s) used	Results
Diphtheria home: <a href="https://www.cdc.gov/diphtheria/">https://www.cdc.gov/diphtheria/</a>	<ul style="list-style-type: none"> <li>Diphtheria: Clinicians. <a href="https://www.cdc.gov/diphtheria/clinicians.html">https://www.cdc.gov/diphtheria/clinicians.html</a></li> <li>Diphtheria: Diphtheria Antitoxin. <a href="https://www.cdc.gov/diphtheria/dat.html">https://www.cdc.gov/diphtheria/dat.html</a></li> <li>Diphtheria: Laboratory. <a href="https://www.cdc.gov/diphtheria/laboratory.html">https://www.cdc.gov/diphtheria/laboratory.html</a></li> <li>Information for Close Contacts of a Diphtheria Patient - Worksheet. <a href="https://www.cdc.gov/diphtheria/downloads/close-contacts.pdf">https://www.cdc.gov/diphtheria/downloads/close-contacts.pdf</a></li> </ul>	4
ACIP	<ul style="list-style-type: none"> <li>Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP).</li> <li>Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)</li> </ul>	16
<i>Epidemiology and Prevention of Vaccine-Preventable Diseases.</i> ("Pink Book")	Chapter 7: Diphtheria	7
<i>Manual for the Surveillance of Vaccine-Preventable Diseases</i>	Chapter 1: Diphtheria	32
MMWR	"toxigenic <i>Corynebacterium diphtheriae</i> "	69
HICPAC Resources	<ul style="list-style-type: none"> <li><i>Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings</i> - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC)</li> <li><i>Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings</i></li> </ul>	2

**Figure 1 Results of Reference Selection Process: Diphtheria**



**Table 2 CDC Group A *Streptococcus* Resources Consulted**

Source	Website browsed or keyword(s) used	Results
<i>Streptococcus</i> , group A infection home: <a href="https://www.cdc.gov/groupastrep/">https://www.cdc.gov/groupastrep/</a>	<ul style="list-style-type: none"> <li>Group A Streptococcal (GAS) Disease: Pharyngitis (Strep Throat). <a href="https://www.cdc.gov/groupastrep/diseases-hcp/strep-throat.html">https://www.cdc.gov/groupastrep/diseases-hcp/strep-throat.html</a></li> <li>Group A Streptococcal (GAS) Disease: Necrotizing Fasciitis: All You Need to Know. <a href="https://www.cdc.gov/groupastrep/diseases-public/necrotizing-fasciitis.html">https://www.cdc.gov/groupastrep/diseases-public/necrotizing-fasciitis.html</a></li> <li>Group A Streptococcal (GAS) Disease Publications and Guidelines: Outbreaks. <a href="https://www.cdc.gov/groupastrep/publications.html#outbreaks">https://www.cdc.gov/groupastrep/publications.html#outbreaks</a></li> </ul>	3
MMWR	"group a' <i>streptococcus</i> healthcare"	221
CDC Resources	<ul style="list-style-type: none"> <li>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</li> <li><i>Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings</i></li> </ul>	59

**Figure 2 Results of Reference Selection Process: Group A *Streptococcus***

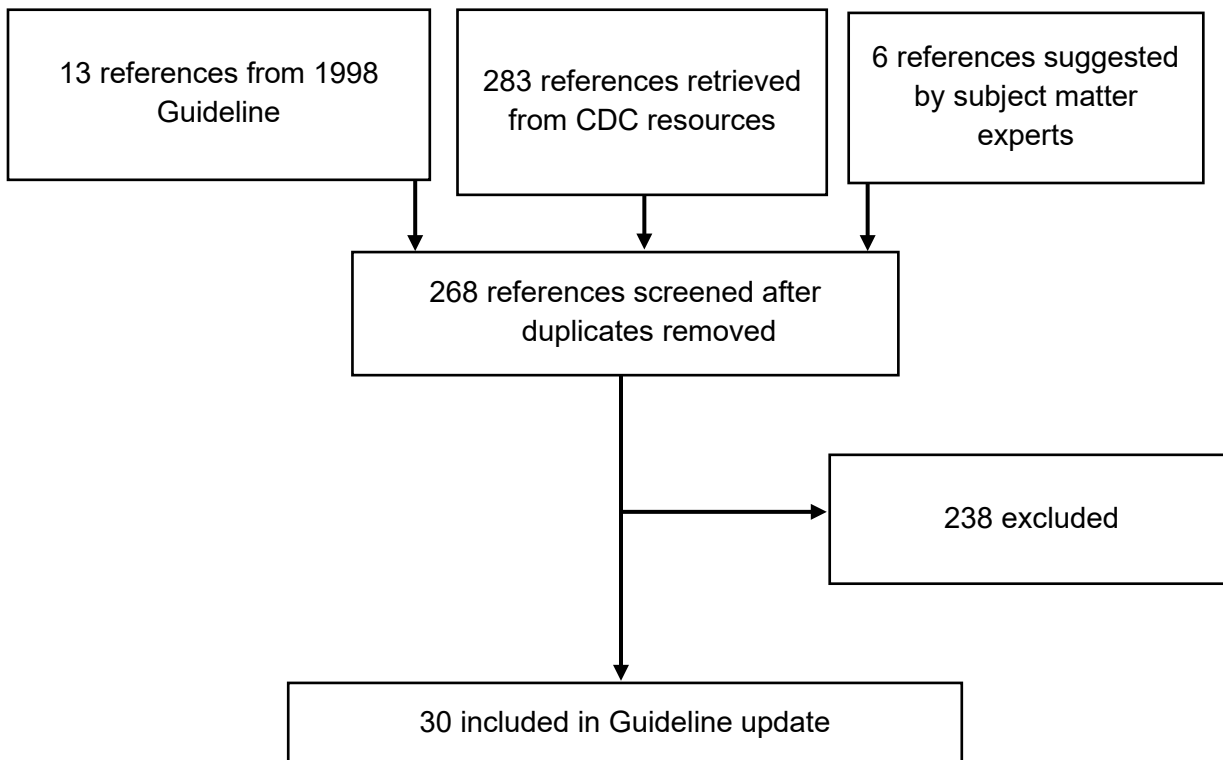


Table 3 CDC Meningococcal Disease Resources Consulted

Source	Website browsed or keyword(s) used	Results
Meningococcal Disease home: <a href="https://www.cdc.gov/meningococcal/index.html">https://www.cdc.gov/meningococcal/index.html</a>	<ul style="list-style-type: none"> <li>• Meningococcal Disease: Technical and Clinical Information. <a href="https://www.cdc.gov/meningococcal/clinical-info.html">https://www.cdc.gov/meningococcal/clinical-info.html</a></li> <li>• Guidance for the Evaluation and Public Health Management of Suspected Outbreaks of Meningococcal Disease <a href="https://www.cdc.gov/meningococcal/downloads/meningococcal-outbreak-guidance.pdf">https://www.cdc.gov/meningococcal/downloads/meningococcal-outbreak-guidance.pdf</a></li> <li>• Meningitis: Laboratory Methods for the Diagnosis of Meningitis Caused by <i>Neisseria meningitidis</i>, <i>Streptococcus pneumoniae</i>, and <i>Haemophilus influenzae</i> <a href="https://www.cdc.gov/meningitis/lab-manual/index.html">https://www.cdc.gov/meningitis/lab-manual/index.html</a></li> </ul>	3
ACIP	<ul style="list-style-type: none"> <li>• Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)</li> <li>• Prevention and control of meningococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP)</li> <li>• Updated Recommendations for Use of MenB-FHbp Serogroup B Meningococcal Vaccine - Advisory Committee on Immunization Practices</li> </ul>	3
<i>Epidemiology and Prevention of Vaccine-Preventable Diseases</i> (“Pink Book”)	Chapter 14: Meningococcal Disease	12
<i>Manual for the Surveillance of Vaccine-Preventable Diseases</i>	<ul style="list-style-type: none"> <li>• Chapter 8: Meningococcal Disease</li> <li>• Vaccines and Preventable Diseases: Meningococcal: Who Needs to Be Vaccinated? <a href="https://www.cdc.gov/vaccines/vpd/mening/hcp/who-vaccinate-hcp.html">https://www.cdc.gov/vaccines/vpd/mening/hcp/who-vaccinate-hcp.html</a></li> </ul>	37
MMWR	“ <i>Neisseria meningitidis</i> healthcare”	96
CDC Resources	<ul style="list-style-type: none"> <li>• <i>Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings</i> - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC)</li> <li>• <i>Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings</i></li> <li>• <i>Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5<sup>th</sup> Edition</i></li> </ul>	3

Figure 3 Results of Reference Selection Process: Meningococcal Disease

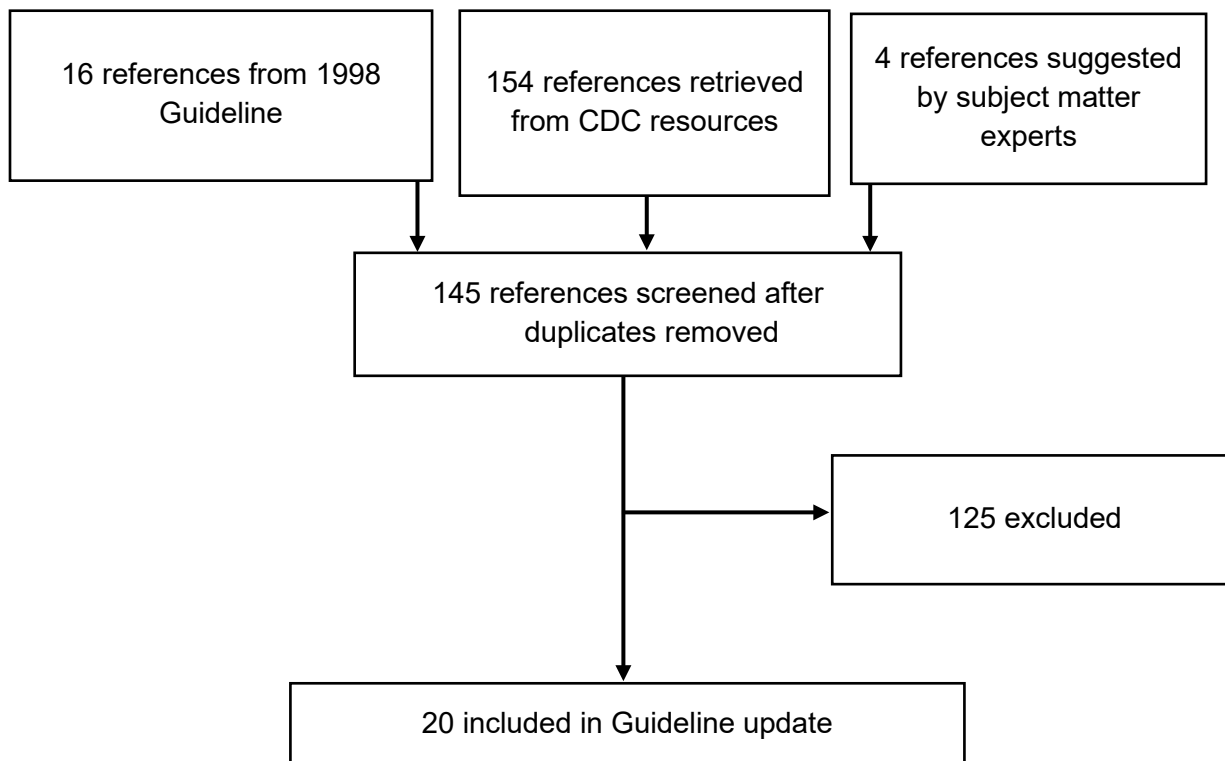


Table 4 CDC Pertussis Resources Consulted

Source	Website browsed or keyword(s) used	Results
Pertussis home: <a href="https://www.cdc.gov/pertussis/">https://www.cdc.gov/pertussis/</a>	<ul style="list-style-type: none"> <li>• Pertussis (Whooping Cough): Clinicians <a href="https://www.cdc.gov/pertussis/clinical/index.html">https://www.cdc.gov/pertussis/clinical/index.html</a></li> <li>• Pertussis (Whooping Cough): Clinical Features. <a href="https://www.cdc.gov/pertussis/clinical/features.html">https://www.cdc.gov/pertussis/clinical/features.html</a></li> <li>• Pertussis (Whooping Cough): About Pertussis Outbreaks. <a href="https://www.cdc.gov/pertussis/outbreaks/about.html">https://www.cdc.gov/pertussis/outbreaks/about.html</a></li> <li>• Pertussis (Whooping Cough): Postexposure Antimicrobial Prophylaxis. <a href="https://www.cdc.gov/pertussis/pep.html">https://www.cdc.gov/pertussis/pep.html</a></li> <li>• Pertussis (Whooping Cough): Diagnostic Testing <a href="https://www.cdc.gov/pertussis/clinical/diagnostic-testing/index.html">https://www.cdc.gov/pertussis/clinical/diagnostic-testing/index.html</a></li> </ul>	5
ACIP	<ul style="list-style-type: none"> <li>• Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP)</li> <li>• Prevention of Pertussis, Tetanus, and Diphtheria with Vaccines in the United States: Recommendations of the Advisory Committee on Immunization Practices (ACIP).</li> </ul>	22
<i>Epidemiology and Prevention of Vaccine-Preventable Diseases.</i> ("Pink Book")	Chapter 16: Pertussis	7
<i>Manual for the Surveillance of Vaccine-Preventable Diseases</i>	<ul style="list-style-type: none"> <li>• Chapter 10: Pertussis</li> <li>• Evaluating Revaccination of Healthcare Personnel with Tdap: Factors to Consider <a href="https://www.cdc.gov/vaccines/vpd/pertussis/tdap-revac-hcp.html">https://www.cdc.gov/vaccines/vpd/pertussis/tdap-revac-hcp.html</a>.</li> </ul>	33
CDC Resources	<ul style="list-style-type: none"> <li>• <i>Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings</i> - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC)</li> <li>• <i>Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings</i></li> <li>• Recommended antimicrobial agents for the treatment and postexposure prophylaxis of pertussis: 2005 CDC Guidelines <a href="https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5414a1.htm">https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5414a1.htm</a></li> </ul>	3



Figure 4 Results of Reference Selection Process: Pertussis

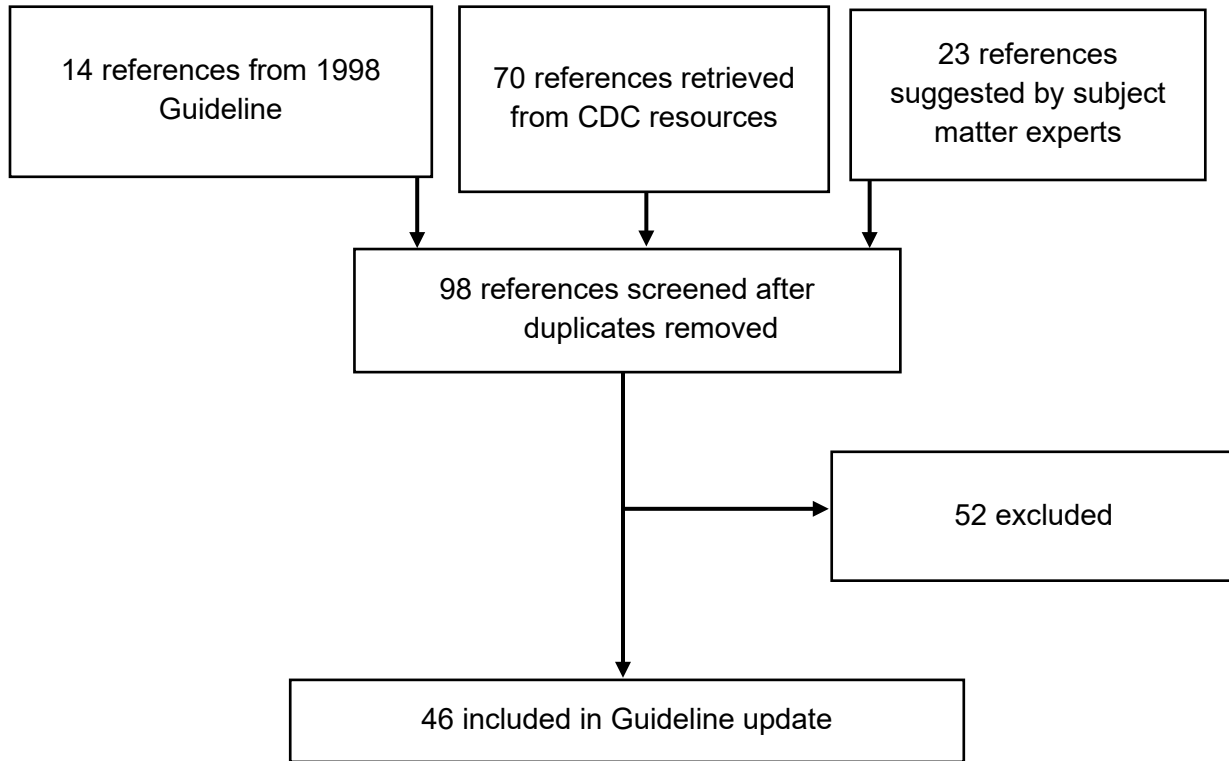
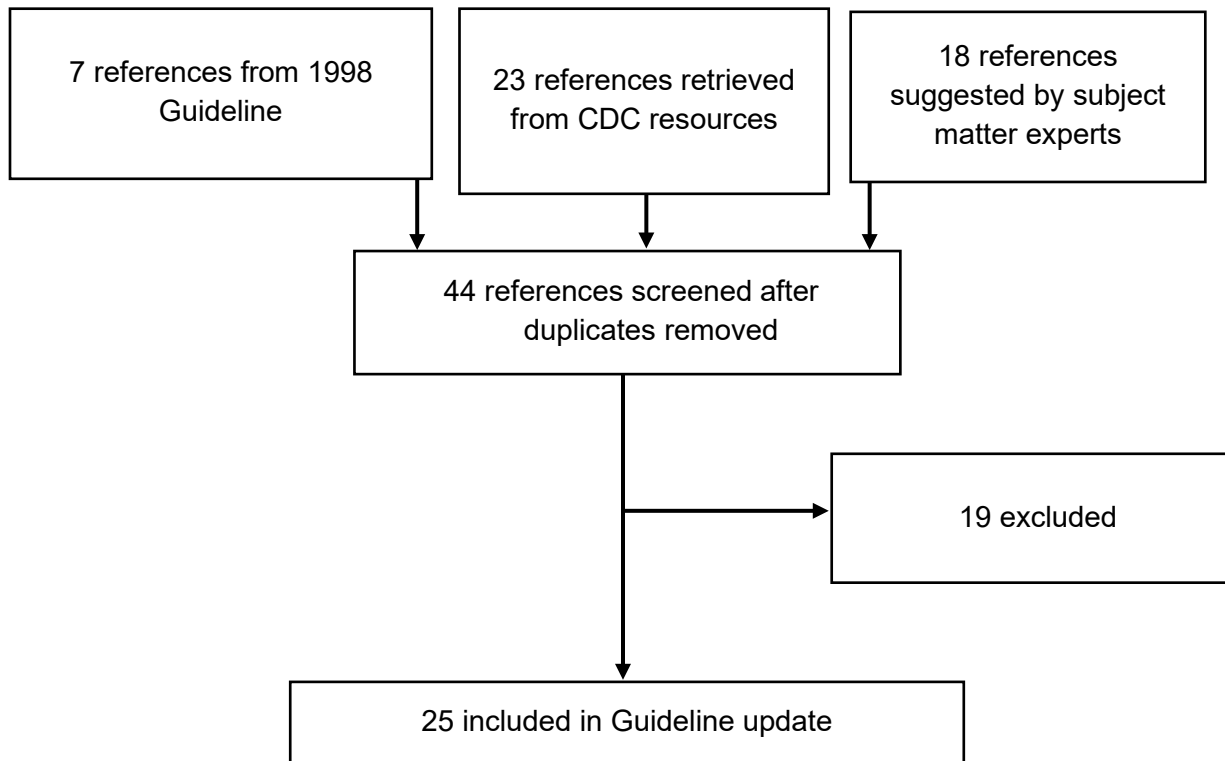


Table 5 CDC Rabies Resources Consulted

Source	Website browsed or keyword(s) used	Results
Rabies home: <a href="https://www.cdc.gov/rabies/index.html">https://www.cdc.gov/rabies/index.html</a>	<ul style="list-style-type: none"> <li>• Rabies: Exposure <a href="https://www.cdc.gov/rabies/exposure/index.html">https://www.cdc.gov/rabies/exposure/index.html</a></li> <li>• Rabies: Diagnosis in Animals and Humans <a href="https://www.cdc.gov/rabies/diagnosis/animals-humans.html">https://www.cdc.gov/rabies/diagnosis/animals-humans.html</a></li> <li>• Rabies: Preexposure Vaccinations <a href="https://www.cdc.gov/rabies/specific_groups/travelers/pre-exposure_vaccinations.html">https://www.cdc.gov/rabies/specific_groups/travelers/pre-exposure_vaccinations.html</a></li> <li>• Rabies: Transmission <a href="https://www.cdc.gov/rabies/transmission/index.html">https://www.cdc.gov/rabies/transmission/index.html</a></li> <li>• Rabies: Signs and Symptoms <a href="https://www.cdc.gov/rabies/symptoms/index.html">https://www.cdc.gov/rabies/symptoms/index.html</a></li> <li>• Rabies: State and Local Rabies Consultation Resources <a href="https://www.cdc.gov/rabies/resources/contacts.html">https://www.cdc.gov/rabies/resources/contacts.html</a></li> <li>• Rabies: Information for Healthcare Providers <a href="https://www.cdc.gov/rabies/specific_groups/hcp/index.html">https://www.cdc.gov/rabies/specific_groups/hcp/index.html</a></li> </ul>	12
ACIP	<ul style="list-style-type: none"> <li>• Use of a Reduced (4-Dose) Vaccine Schedule for Postexposure Prophylaxis to Prevent Human Rabies</li> </ul>	1
MMWR	"Rabies virus"	28
HICPAC Resources	<ul style="list-style-type: none"> <li>• <i>Core Infection Prevention and Control Practices for Safe Healthcare Delivery in all Settings</i> - Recommendations of the Healthcare Infection Control Practices Advisory Committee (HICPAC)</li> <li>• <i>Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings</i></li> <li>• <i>Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5<sup>th</sup> Edition</i></li> </ul>	3

Figure 5 Results of Reference Selection Process: Rabies



## Appendix 3: Contributors and Acknowledgements

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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:

- 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).
- 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.