



INTERNATIONAL
SOCIETY
FOR INFECTIOUS
DISEASES

GUIDE TO INFECTION CONTROL IN THE HEALTHCARE SETTING

Diphtheria, Tetanus, Pertussis

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KEY ISSUE

Active immunization of the general population is effective to control the transmission of diphtheria, tetanus, and pertussis infections in the community, and the possible risk of infection in the healthcare setting.

KNOWN FACTS

- *Corynebacterium diphtheriae* (causative agent of diphtheria) and *Bordetella pertussis* (causative agent of pertussis or whooping cough) are transmissible from person to person, whereas *Clostridium tetani* (causative agent of tetanus) is not.
 1. Transmission of *C. diphtheriae* occurs from person to person through droplets and close physical contact with secretions from the nose, throat, eye (pharyngeal diphtheria), or skin (cutaneous diphtheria) of patients or carriers.
 2. Transmission of *B. pertussis* occurs by close contact via aerosolized droplets from patients with disease. Infants <4 months are at highest risk of severe disease.
 3. Transmission of *C. tetani* occurs by introduction of tetanus spores through a contaminated wound. This is more common after natural disasters in developing countries where immunization coverage is quite low. Tetanus spores can also be introduced via the umbilical cord during delivery, causing tetanus neonatorum, an important health problem in developing countries. In addition the spores can enter the body through unclean burn, surgery, and dental extraction. The site of entry is some times unknown and at the time of presentation could have healed.
- Diphtheria, tetanus, and pertussis are mainly community-acquired infections. The high immunization coverage obtained by immunization programs in industrialized countries and by the WHO EPI (Expanded

Programme on Immunization) has considerably reduced the global burden of these diseases.

- Universal vaccination during infancy against these 3 illnesses is done using a combination vaccine.
- Diphtheria and tetanus vaccines consist of single purified antigens: diphtheria and tetanus toxoids. Diphtheria vaccines used for children until the age of 6 years contain 6.7 to 30 flocculation units (Lf) of toxoid, whereas a vaccine with a reduced amount of antigen (not more than 2 Lf) should be used for individuals older than 6 years.
- There are 2 types of pertussis vaccines: whole cell vaccine (Pwc) and acellular vaccines (aP). The oldest and most widely used is the Pwc vaccine. This vaccine is highly protective, although there are differences between preparations. Pwc vaccines are usually not administered after the age of 7 years. aP vaccines consist of 2 or 3 purified antigens. They are less reactogenic than Pwc vaccines and have demonstrated their protective efficacy in clinical trials. However the duration of protection is probably shorter than that afforded by Pwc preparations. Combination of aP vaccines with other vaccines recommended for infant immunization (diphtheria, tetanus, IPV/inactivated polio vaccine, Hib/*Haemophilus influenzae* type b, and HBV/Hepatitis B virus) exist. Acellular pertussis-based vaccines remain significantly more expensive than whole cell preparations.
- Long-term protection against diphtheria, tetanus, and pertussis by vaccination requires primary immunization followed by the administration of booster doses of these vaccines.
- aP vaccines for use in adolescents and adults are available.
- Older children and adults with mild or atypical disease are the source of contamination for infants, thus pertussis vaccination of adolescents and adults is recommended in an attempt to obtain longer term protection and to provide indirect protection to infants.

- A "cocoon strategy", defined as protecting vulnerable patients from infectious diseases by vaccinating those in close contact with them, had been advocated as a strategy.
- Cocooning immunization does not provide infants with antibodies, thus it is important to have pregnant women receive the vaccine.
- Transmission of diphtheria and pertussis in the hospital setting, although very rare, can occur. An infected patient can be the source of diphtheria or pertussis transmission whereas contaminated surgical material has been reported as a possible cause of tetanus.

CONTROVERISAL ISSUES

- Rare severe neurological events leading to permanent brain damage occurring in infancy have been attributed to immunization with Pwc vaccine in the years 1970s, leading to the interruption of pertussis vaccination programs in some industrialized countries. This has been followed by a recrudescence of pertussis in these countries, thereby demonstrating the role of vaccination in controlling the disease. Whether these neurological events were only temporally related or caused by vaccination has been a source of controversy. One large case control study performed in England has not established a causal relationship between such neurological events and pertussis vaccination.
- Pa vaccines have been demonstrated to be effective in large clinical trials. However, in recent years, a recrudescence in the number of cases of pertussis has been reported in several countries where the Pa vaccines have replaced Pw vaccines in the immunization programs, warranting the use of booster doses in adolescence and adulthood.
- Pwc vaccines are widely used in countries with limited resources. In a number of industrialized countries, Pwc vaccines are still preferred on the basis of cost benefit evaluations and/or demonstrated long-term effectiveness.

SUGGESTED PRACTICE

- All interventions that allow reaching high vaccine coverage should be promoted (see *Table 34.1*). Vaccination schedules vary according to local practice; guidelines are proposed by WHO EPI.
- Diphtheria and pertussis are transmissible from person to person and thus adequate isolation precautions should be in place in hospitals to prevent hospital transmission.
- Tetanus is not transmissible from person to person, and thus the aim is to avoid rare cases of infections related to contaminated hospital material and maintaining adequate standard of care for wound management and obstetrical practice (see *Table 34.2*).

SUGGESTED PRACTICE IN UNDER-RESOURCED SETTINGS

- Pertussis infection rate is highest among unvaccinated children and the teens.
- Consideration should be given to vaccinate pregnant women in the second-trimester to increase neonatal antibodies.
- Improve childhood immunization for pertussis and diphtheria through EPI.
- Focus on proper delivery and training of individuals assessing the deliveries to prevent neonatal tetanus
- Control neonatal tetanus to <1 case/1000 live birth in each health district by having a high vaccine coverage of tetanus toxoid of pregnant women and proper neonatal cord handling.
- The World Health Organization continues to recommend the use of DTwP (diphtheria, tetanus, whole cell pertussis) in resource-poor countries.

Table 34.1 Interventions to Reach High Vaccine Coverage against Diphtheria, Tetanus, and Pertussis

- Universal childhood vaccination against diphtheria, tetanus, and pertussis consisting of 3 to 4 doses of combination vaccine starting not later than 3 months of age.
- Administration of a booster dose of diphtheria-tetanus vaccine at the age of 4 to 6 years, combined with acellular pertussis if affordable and of a booster dose of diphtheria-tetanus every 10 years thereafter.
- In countries using acellular pertussis vaccines in their childhood immunization programs, the booster used at adolescence should be a diphtheria-tetanus-acellular pertussis formulation suitable for use in adults. Strategies of adult vaccination should be implemented for indirectly protecting infants as vaccine-induced immunity wanes.

- Administration of a booster dose of diphtheria-tetanus and human tetanus immunoglobulins according to previous vaccination and based on the severity of the wound.
- In countries where a significant proportion of women of childbearing age are not immunized against tetanus, implementation of vaccination programs of pregnant women according to WHO EPI guidelines.

Table 34.2 Measures to Prevent Hospital Transmission of Diphtheria, Tetanus, and Pertussis

Diphtheria
<ul style="list-style-type: none"> • Patient isolation: standard + droplets for patients and carriers with pharyngeal diphtheria; contact for cutaneous diphtheria. The isolation should be continued until 2 cultures taken 24 hours after completing antimicrobial treatment are negative. • Promptly identify close contacts and implement the following: <ol style="list-style-type: none"> 1. Throat culture for <i>C. diphtheriae</i>. 2. Review of prior history of vaccination, completion of primary program if pending, or administration of a booster dose of vaccine appropriate for age if last dose not given within the preceding 5 years. 3. Surveillance for 7 days for evidence of disease. 4. Erythromycin for 7 days or a single intramuscular injection of penicillin G benzathine to close contacts irrespective of their immunization status.
Tetanus
<ul style="list-style-type: none"> • Ensure adequate sterilization of hospital supplies (surgical, injections, and suture material) • Ensure proper obstetrical practices, including sterile umbilical cord cutting.
Pertussis

- Patient isolation: in addition to standard precautions, droplet precautions are needed for 5 days after starting effective therapy, or for 3 weeks after onset of cough if appropriate therapy was not given.
- Identification of exposed individuals and implementation of the following:
 1. Completion of primary immunization if not completed or administration of a booster vaccine if the last vaccine dose has been given >3 years.
 2. Monitor exposed individuals for 21 days after exposure for evidence of disease.
 3. Macrolide (azithromycin, erythromycin, or clarithromycin) or TMP-SMX (trimethoprim/sulfamethoxazole; contraindicated for <2 months of age) to close contacts regardless of immunization (vaccine induced protection is not absolute and wanes with time and there is no booster given after 7 years of age).

SUMMARY

Corynebacterium diphtheria, the causative agent of diphtheria, and *Bordetella pertussis* (causative agent of pertussis or whooping cough) are transmissible from person to person, whereas *Clostridium tetani* (causative agent of tetanus) is not. Transmission of *C. diphtheriae* occurs from person to person through droplets and close physical contact with secretions from the nose, throat, eye (pharyngeal diphtheria), or skin (cutaneous diphtheria) of patients or carriers. Transmission of *B. pertussis* occurs by close contact via aerosolized droplets from patients with disease. Transmission of *C. tetani* occurs by introduction of tetanus spores through a contaminated wound. Universal vaccination during infancy against these 3 diseases is an excellent strategy for prevention.

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