UK Health Security Agency

National pertussis guidance

Advice on the public health management of pertussis

May 2026

Contents

Document history

Date	Reason for change	Issue number
May 2026	New document created from merging UKHSA Guidance on the management of cases of pertussis in England during the re-emergence of pertussis in 2024, PHE Guidelines for the Public Health Management of Pertussis in England, PHE Guidelines for the Public Health Management of Pertussis Incidents in Healthcare Settings, and PHE Guidelines for pertussis outbreaks in nurseries and educational settings	1.0

Executive summary

This guidance has been developed principally to aid the public health management of pertussis by UKHSA health protection teams (HPTs) and their partners. It supersedes UKHSA's guidance on management of pertussis during periods of high activity which was released in 2024 in response to the large, national outbreak that was unfolding at that time, and brings together material from a series of older guidance documents (for general public health management, healthcare settings and educational settings respectively).

Public health action is not required for *Bordetella parapertussis* infection.

Outside of periods of higher pertussis activity, the recommended exclusion period for untreated pertussis cases, along with the timeframes for considering antibiotic treatment for cases and chemoprophylaxis for eligible close contacts, is 21 days.

The remainder of this section summarises key recommendations concerning public health management of pertussis cases (Box 1) and contacts of cases (Box 2); and actions in the event of an outbreak in a healthcare or educational setting (Box 3). The emphasis in public health management is on protecting individuals falling into 2 priority groups for public health action:

Group 1: Individuals at increased risk of severe complications ('vulnerable')

A. Unimmunised infants (born at less than 32 weeks) under 2 months of age regardless of maternal vaccine status.

B. Unimmunised infants (born from 32 weeks) under 2 months of age whose mothers did not receive maternal pertussis vaccine after 16 weeks and at least 2 weeks before delivery.

C. Infants from 2 months to less than 5 months of age, regardless of maternal vaccination status or gestational age at delivery.

D. Infants from 5 months to less than 1 year of age who have received less than 3 doses of a pertussis-containing vaccine (for example, DTaP/IPV/Hib/HepB), regardless of maternal vaccination status or gestational age at delivery.

Group 2: Individuals at increased risk of transmitting to 'vulnerable' individuals in 'group 1' if they have pertussis, who have either not received a pertussis-containing vaccine within the past 5 years, or received the vaccine within the previous week

A. Pregnant women who have reached 32 weeks' gestation.

B. HCWs who provide close personal care to infants (as defined in Group 1 above) and pregnant women.

C. People whose work involves regular, close and prolonged contact with infants as defined in Group 1 above (for example, nursery workers in baby rooms or childcare workers providing close personal care to infants).

D. People who share a household with an infant as defined in 'vulnerable' infants in Group 1 above.

Recommendations focus particularly on advice for the following groups:

- members of the public who have close contact with infants and/or pregnant women (for example, at home)
- healthcare workers who have close contact with infants and/or pregnant women because of the clinical work that they do
- nursery and/or childcare workers who have close contact with vulnerable infants in the work that they do

Box 1. Public health management of an index case

Exclusion of an index case

- exclude cases from work or school for 48 hours following commencement of recommended antibiotic therapy, or for 21 days following the onset of coughing if they are not being treated;
- cases who are hospitalised patients should be placed in respiratory isolation until 48 hours of treatment is completed or for 21 days from onset if untreated.

Antibiotic therapy for an index case

- consider antibiotics as soon as possible after onset of illness and up to 21 days from onset of cough.

Vaccination for an index case

- unvaccinated and partially immunised cases up to 10 years of age should be advised to complete their course of primary immunisation and booster vaccine once they have recovered from their acute illness;
- pregnant women who have reached 16 weeks' gestation and have not been vaccinated in this pregnancy should be offered a dose of pertussis-containing vaccine once they have recovered from their acute illness

Box 2. Public health management of contacts of an index case

General considerations

- exclusion of asymptomatic close contacts is not required
- in healthcare settings, risks to others from exposures are likely to be context specific and where special conditions may apply (for example, in paediatric intensive care or special care baby unit settings) dedicated assessments led by the employer should be carried out to determine who would qualify as a contact and what management may be most appropriate

Chemoprophylaxis for close contacts

- in households and other close contact settings (for example, hospital inpatient bays) where there are no close contacts who fall into one of the priority groups for public health action, chemoprophylaxis is **not** required
- in households and other close contact settings (for example, hospital inpatient bays) where there is one or more close contacts who fall into one of the priority groups for public health action, antibiotic chemoprophylaxis is recommended to **all** close contacts provided exposure occurred during the infectious period (up to 21 days from onset of cough in the index case) and chemoprophylaxis can be given within 21 days of last exposure
- guidance on choice of antibiotic agent is given elsewhere in this guidance (see Appendix 5.8), but pregnant women who are close contacts should be offered erythromycin, if exposed after 32 weeks of pregnancy and provided that (i) the exposure occurred within 21 days of onset of cough in the index case, and (ii) they have either not received a pertussis containing vaccine within the past 5 years, or were vaccinated within the previous week

Vaccination for close contacts

- unimmunised and partially immunised contacts up to the age of 10 years should complete the schedule with the appropriate vaccine in accordance with UKHSA guidance
- a booster dose of pertussis containing vaccine is recommended for individuals aged 10 years or older who have not received a dose of pertussis-containing vaccine in the last five years and no Td-IPV vaccine in the preceding month
- pregnant contacts who have reached or passed the 16th week of their pregnancy but have not yet received a pertussis-containing vaccine during their current pregnancy should be offered vaccination, ideally after the detailed ultrasound scan.
- healthcare worker contacts who provide close personal care to infants in Group 1 or pregnant women, and who have not received a booster dose of pertussis-containing vaccine more than 1 week and less than 5 years ago: should be offered vaccination

Box 3. Management of outbreaks in healthcare and educational settings

- where an outbreak is identified in a healthcare or educational setting (defined as 2 or more confirmed, or at least 1 confirmed and 1 clinically suspected, cases of pertussis in a given setting within 42 days), the HPT should undertake investigation and risk assessment, this may require an incident management team (IMT) to be convened to support risk assessment and provide recommendations on appropriate management
- general approaches to outbreak management in educational settings may be summarised as follows, by setting type, as in table below

Educational setting	Chemoprophylaxis	Vaccination
Scenario 1: Nursery	May be appropriate to consider widespread chemoprophylaxis.	Widespread booster vaccinations are unlikely to be required.
Scenario 2: Primary school	Chemoprophylaxis is not recommended in this setting other than in exceptional circumstances.	Widespread administration of a booster vaccination may be appropriate.
Scenario 3: Secondary school	Chemoprophylaxis is not normally recommended in this setting.	Widespread vaccination is not normally recommended.
Scenario 4: Boarding school	Consideration needs to be given to whether the boarding school environment is considered to be equivalent to a household setting. In this case, chemoprophylaxis should be provided.	Vaccination is likely to be recommended, but the IMT needs to consider whether this is in the form of a mass booster or catch-up programme.

1. Background

1.1 Introduction

1.1.1 Pertussis: the disease

Pertussis (whooping cough) is an acute bacterial infection that is caused by *Bordetella pertussis* and can affect people of all ages. While adolescents and adults tend to have a prolonged cough illness but without other symptoms, young, unimmunised infants are the most vulnerable group and have the highest rates of morbidity and mortality from infection. Transmission of infection occurs through close, direct contact with an infected person (1).

The incubation period of pertussis is on average between 7 to 10 days (range 5 to 21 days). The usual clinical presentation is an initial catarrhal stage with a cough that becomes paroxysmal. Paroxysms of cough usually increase in frequency and severity as the illness progresses and persist for 2 to 6 weeks. These paroxysms may end in vomiting, cyanosis and/or a characteristic inspiratory whoop.

Patients with pertussis are most infectious in the initial catarrhal stage and during the first 3 weeks after the onset of cough (2). Symptoms slowly improve in the convalescent phase, which generally lasts 2 to 6 weeks but can persist for months. Adults generally have a non-productive cough illness without fever (3). Serious complications include pneumonia, seizures and encephalitis. Vaccination is the most effective strategy for preventing pertussis transmission in the population, although protection afforded by vaccination or from past infection is not lifelong.

1.1.2 Epidemiological overview

A brief history of pertussis control in England

A full review of the history of pertussis control in England is beyond the scope of this document, but an understanding of key changes over time is important in contextualising current pertussis epidemiology, and for interpreting guidance recommendations. Whole-cell (wP) pertussis vaccination was introduced into the UK routine childhood immunisation schedule in the 1950s and contributed to sizeable reductions in infection caseload over time (4). The current, accelerated primary schedule of 3 doses at 2, 3, and 4 months of age was introduced in 1990, initially using wP but shifting to acellular vaccination (aP) in 2004. In addition, an aP booster was introduced in 2001 at 3 years 4 months to 5 years of age to help provide longer-lasting protection from severe outcomes of pertussis.

In the wake of a large, national outbreak of pertussis in 2011 to 2012, a temporary immunisation programme for pregnant women was introduced from October 2012. The maternal programme was integrated into the routine schedule from 2019 onwards (5). The primary purpose of this programme is to boost maternal pertussis antibodies that are transferred from mother to infant

to provide passive protection from birth and before these infants are old enough to have completed a primary course of immunisation themselves.

The evolving epidemiology of pertussis in England

Pertussis has historically had a cyclical pattern of incidence with peaks occurring every 3 to 4 years. Incidence is usually higher in England between July and September. While the burden of disease in children under 1 year has fallen since the introduction of the accelerated schedule against a context of comparatively high, sustained uptake of childhood vaccination by comparison with many other countries, incidence of disease continues to be highest in infants under 3 months of age, followed by adolescents aged 10 to 14 years (6). Higher case numbers observed in adolescents by comparison with the years prior to 2006 are likely due in large part to better case ascertainment following the introduction of serological testing in 2001 (7). The concentration of severe disease in young infants underpins the continuing emphasis on protecting infants in public health recommendations in this document and elsewhere.

Prior to the SARS-CoV-2 pandemic, resurgences of pertussis had been observed in several years across England, in addition to other countries with longstanding vaccination programmes (such as Wales, Australia and the USA), despite high levels of vaccine uptake (8). However, intervention measures implemented to help control the spread of SARS-CoV-2 between March 2020 and July 2021 had a significant, additional impact on the transmission of other infectious diseases including pertussis. Consequently, pertussis activity was exceptionally low across England from April 2020 and remained low until summer 2023 when case numbers began to increase. In 2024 there was a large, national outbreak of pertussis across all regions of England, with a total of 14,879 laboratory-confirmed cases reported (9).

A range of potential explanations for the observed increased in pertussis incidence in recent years have been proposed. The 2024 outbreak has been attributed in large part to lower population-level immunity following the imposition of social interventions to reduce mixing during the COVID-19 pandemic (10). More generally, there is growing evidence that the shorter duration of protection and lower effectiveness against infection conferred by aP vaccines compared with wP vaccines have been important contributory factors (6, 11 to 13). This is particularly relevant in Europe where a high proportion of countries switched from a whole cell to acellular primary schedule from the mid-1990s and where in 2017, a total of 42,242 cases were reported (14). In the UK, aP vaccines replaced wP vaccines in the accelerated primary infant schedule (2, 3 and 4 months) in 2004, later than many other high-income countries.

1.1.3 Scope and intended audience of this guidance

This document outlines recommendations – and their underpinning evidence – concerning the identification and public health management of pertussis cases and their contacts. It also includes recommendations on outbreak management.

This document is intended primarily to support UKHSA health protection teams (HPTs) leading the public health management of pertussis cases, but also for colleagues working across the health, social care, and education sectors in promoting prompt identification of, and action on, potential cases of the disease.

1.1.4 How this guidance is organised

This document supersedes UKHSA's guidance on management of pertussis during periods of high activity which was released in 2024. Recommendations outlined in this document also supersede those provided in earlier Public Health England (PHE) and UKHSA guidance, including the Guidelines for Management of Pertussis in England, Guidelines for Public Health Management of Pertussis Incidents in Healthcare Settings, and Guidelines for pertussis outbreaks in nurseries and educational settings – all of which have been brought together here. Finally, recommendations in this guidance take into account evolving evidence on the effectiveness of some public health measures identified in previous pertussis guidance documents issued by PHE and the current epidemiological context – and have been revised accordingly.

The guidance is organised in 4 main parts:

Part 1 sets out the rationale for public health action on pertussis and approaches to laboratory testing and surveillance.

Part 2 sets out recommendations for general public health management of cases and their contacts.

Part 3 sets out recommendations for specific settings, including in healthcare and educational contexts.

Part 4 provides a summary of key evidence used to inform recommendations made elsewhere in the document.

The appendices (Part 5) bring together a series of accessory tools to support those involved in the management of cases, including summary algorithms and template letters for communication.

1.2 Rationale for public health action

1.2.1 Principles underpinning public health management recommendations

The recommendations in this document are set out in accordance with a set of principles concerning the public health management of pertussis, principally that:

- the key priorities for pertussis are to (i) prevent infant hospitalisations and deaths and (ii) highlight the importance of timely and complete vaccination in pregnancy, infants and children under 10 years
- the benefits of treatment for suspected pertussis are greatest where initiated as soon as possible after illness onset. Testing for pertussis (and in particular oral fluid testing) is important for surveillance but should not delay management
- risk of transmission of pertussis is greatest in households and in institutional settings where close contact is more likely to occur. Prompt action in these settings can limit spread of infection especially to those who are most at risk of severe or complicated infection such as infants and young children – and is therefore a priority focus for public health recommendation
- evidence of effectiveness of chemoprophylaxis outside settings in which household-type contact is likely, is limited. In all settings, chemoprophylaxis is more effective the earlier it is administered post-exposure
- public health actions should be proportionate to the additional level of risk in any given scenario, relative to background risk, and should be based on risk assessment as appropriate

Pre-exposure vaccination remains the centrepiece of public health action on pertussis. Vaccination in pregnancy is key to passively protecting babies before they can be directly protected by the infant vaccine programme. Analysis of data from England continues to indicate very high levels of protection against disease, hospitalisation and death from pertussis in infants under three months of age born to mothers who had been vaccinated in the relevant pregnancy. It is also very important that babies are vaccinated on time at 8, 12 and 16 weeks of age wherever possible and that those who miss vaccination are caught up at the earliest opportunity. Recent declines in uptake of the maternal pertussis vaccine (15) and coverage of the primary infant schedule in recent years (16) are therefore of particular concern.

Bordetella parapertussis infection does not require public health action, as it causes a generally milder disease than pertussis due to the absence of pertussis toxin production.

1.2.2 Definitions of vulnerable groups

Definitions for vulnerable groups applied throughout this guidance are given below. These definitions are based on an assessment of currently available evidence on variations in risk by population, as summarised in section 4.2. In particular, they reflect the increased risk of severe disease and death in infants (especially those who are unimmunised) and the focus on minimising risk of transmission to those who are most vulnerable.

Group 1: Individuals at increased risk of severe complications ('vulnerable')

A. Unimmunised infants (born at less than 32 weeks) under 2 months of age regardless of maternal vaccine status.

B. Unimmunised infants (born from 32 weeks) under 2 months of age whose mothers did not receive maternal pertussis vaccine after 16 weeks and at least 2 weeks before delivery.

C. Infants from 2 months to less than 5 months of age, regardless of maternal vaccination status or gestational age at delivery.

D. Infants from 5 months to less than 1 year of age who have received less than 3 doses of a pertussis-containing vaccine (for example, DTaP/IPV/Hib/HepB), regardless of maternal vaccination status or gestational age at delivery.

Group 2: Individuals at increased risk of transmitting to 'vulnerable' individuals in 'group 1' if they have pertussis, who have either not received a pertussis-containing vaccine within the past 5 years, or received the vaccine within the previous week

A. Pregnant women who have reached 32 weeks' gestation.

B. HCWs who provide close personal care to infants (as defined in Group 1 above) and pregnant women.

C. People whose work involves regular, close and prolonged contact with infants as defined in Group 1 above (for example, nursery workers in baby rooms or childcare workers providing close personal care to infants).

D. People who share a household with an infant as defined in 'vulnerable' infants in Group 1 above.

1.3 Public health surveillance of pertussis

Pertussis remains a notifiable disease under the Health Protection Legislation (England) Guidance 2010. Effective surveillance is critical to timely identification and action on cases, and outbreaks of pertussis, and to informing the design and evaluation of the national immunisation programmes which remain the bedrock of disease prevention.

Since October 2010, all diagnostic laboratories have been required to report confirmed cases of B. pertussis infection to their local HPT (17). As per national guidance on notification of infectious diseases, suspected cases in the acute phase should be notified to the local HPT by telephone urgently (within 24 hours), or on a routine basis (within 3 days) if a late diagnosis (18).

Staff at the UKHSA Immunisation and Vaccine Preventable Diseases (IVPD) division follow-up all cases of confirmed pertussis with GPs to obtain further epidemiological and clinical information including details such as vaccination status (see template enhanced surveillance form in Appendix 5.4).

HPTs are strongly encouraged to report all severe cases and pertussis-related deaths to the IVPD in a timely manner (via pertussis@ukhsa.gov.uk if reporting from a UKHSA email address, or phe.pertussis@nhs.net if using an nhs.net account) using the appropriate surveillance form (see Appendix 5.5). This form replaces the UKHSA enhanced pertussis surveillance form for fatal and severely unwell cases, collecting similar information via HPTs rather than directly from general practices as this can be challenging where cases have died.

In addition, HPTs are requested to notify IVPD of any outbreaks in healthcare settings by submitting the relevant reporting form (see Appendix 5.6) to pertussis@ukhsa.gov.uk. Single suspected or confirmed cases in healthcare workers will be extracted from the public health case management system (CIMS).

UKHSA IVPD is also responsible for reporting epidemiological data on pertussis annually to the World Health Organisation (WHO) European region.

2. Public health management

Pertussis cases are considered infectious from onset of coughing until 48 hours after commencement of appropriate antibiotic treatment, or 21 days from onset of their cough if not receiving treatment.

Pertussis testing for the majority of cases, especially amongst adolescents and adults where serological methods are primarily used for confirmation, is unlikely to deliver results in a way that will influence timely case management. Where onset date has not been provided to the local unit, it is reasonable to assume that serologically and oral fluid confirmed cases are reported too late for immediate public health action. See Appendix 5.1 for a suggested process for HPT actions.

Recommendations in this section focus on the following groups:

- general members of the public
- people who are in contact in their households or another close contact setting (for example, an in-patient bay in a hospital) with someone meeting the priority group definitions in section 1.2.2
- healthcare workers providing care to people meeting the priority group definitions in section 1.2.2
- people who work in a nursery or other childcare setting providing close personal care to infants (per priority group definitions in section 1.2.2)

2.1 Case management

2.1.1 Case and outbreak definitions

This guidance reaffirms case definitions for pertussis as follows:

Suspected case of pertussis:

Any person in whom a clinician suspects pertussis infection. This may include individuals presenting with a new onset cough without a clear alternative cause and one or more of the following features:

- paroxysms of coughing
- post-tussive vomiting
- inspiratory whoop
- cough of duration 14 days or more
- apnoeic episodes in infants

(In the absence of laboratory confirmation or epidemiological link to a laboratory confirmed case.)

Confirmed case of pertussis:

Any person with signs and symptoms consistent with pertussis and:

- *B. pertussis* is isolated from a respiratory sample (NPA/NPS/PNS)

Or:

- anti-pertussis toxin IgG titre >70 IU/ml (serum) or >70 aU (OF) is detected in a specimen (in the absence of vaccination in the past year)

Or:

- *B. pertussis* PCR positive in a respiratory clinical specimen

Epidemiologically linked case of pertussis:

Any person with signs and symptoms consistent with pertussis and:

- was in close contact with a laboratory confirmed case of pertussis in the 21 days before onset of their cough (in the absence of laboratory confirmation)

The guidance further confirms the outbreak definition for pertussis as follows:

An **outbreak** of pertussis is defined as 2 or more confirmed (or at least 1 confirmed and 1 clinically suspected) cases of pertussis within 42 days (2 incubation periods) where transmission is likely to have occurred in the setting.

2.1.2 Risk assessment for the index case

2.1.2.1 General approach to risk assessment

The positive predictive value (PPV) of a clinical diagnosis of pertussis is not very high, particularly among adolescents and adults who may present with atypical features. However, the PPV will increase during periods of heightened pertussis activity and will vary with age. Risk assessment should be based on a combination of clinical and epidemiological factors such as clinical presentation, vaccination history and epidemiological links. Management of the index case and any vulnerable contacts should proceed based on this risk assessment without waiting for the results of laboratory testing and prompt public health actions to prevent onward transmission should be considered.

Cases reported to the UKHSA HPT more than 21 days following cough onset require no public health action, since the period of exclusion for these cases will have elapsed and they are unlikely to benefit meaningfully from antibiotic therapy.

2.1.2.2 Risk assessment in specific settings

Cases among hospital inpatients

Risk assessment considerations for patients should typically follow those outlined in section 2.1.2.1. However, special considerations may apply in settings such as neonatal intensive care units (NICU), special care baby units (SCBU) paediatric intensive care units (ITU), or high dependency units (HDU). For a child admitted to NICU/SCBU/Paediatric HDU or ITU with pertussis, a risk assessment needs to be undertaken to determine the need for wider prophylaxis. This will include identifying whether the case was ventilated, if this was a closed or open circuit and whether there is a possibility of breaks in the ventilatory circuit leading to exposure risk. If in doubt, contact the local HPT for assistance in risk assessment in these circumstances.

Cases in healthcare workers, and nursery workers or childcare workers providing close, personal care to vulnerable infants

Consideration should be given to the following risk assessment questions:

1. Does the case provide care to priority group patients, that is, pregnant women or infants?
2. Has the case worked during the infectious period?
3. Can action be taken for at-risk contacts (as defined above in section 1.2.2) within 21 days of exposure to the case?

If the answer to all the above is yes, then the need for wider chemoprophylaxis and vaccination for contacts should be considered (see section 2.2 for further guidance). If not, then inform and advise contacts with significant exposure to seek medical attention if they develop symptoms suggestive of pertussis (see template letters in Appendix 5.7, depending on the setting). HCW contacts who develop symptoms should also inform their occupational health department.

2.1.3 Laboratory confirmation

Appropriate public health action should not wait for laboratory results, as negative results cannot be used to exclude pertussis infection. Laboratory testing for pertussis remains important, as positive results confirm cases and support surveillance, outbreak detection and epidemiological understanding; however, due to the stage-dependent sensitivity of available tests, negative results do not reliably exclude infection (see Figure 1).

In the event of an outbreak, the local HPT and the testing laboratory should be informed in order that testing can be appropriately prioritised.

Recommendations regarding laboratory confirmation by age of the suspected case are as follows:

- **PCR testing** is recommended for all age groups presenting less than 21 days from onset of cough. PCR for pertussis is available from UKHSA Public Health Microbiology Clinical Network Laboratories. UKHSA SMS laboratories should be contacted directly for details of services provided.
- **Culture** should also be performed where local laboratory facilities permit. Please ask the local laboratory for any putative *B.pertussis* isolates (pure cultures) to be sent to the UKHSA Respiratory and Vaccine Preventable Bacteria Reference Unit (RVPBRU) for confirmation.
- **Serology** can be considered for anyone aged over 1 year old with more than 14 days history of cough and at least one year after the most recent dose of pertussis vaccine (including any dose administered in pregnancy). It is not typically recommended in infants as antibody response in children of this age group may not be typical of that seen in older children and adults.
- **Oral fluid (OF) testing** is recommended for notified cases aged 2 to 16 years, with a history of more than 14 days of cough **and** at least one year after the most recent dose of pertussis-containing vaccine. The test kit is available from UKHSA HPTs upon notification of suspected cases. Testing is performed by the RVPBRU for surveillance purposes

A summary of these options, sample types and available access points for sample testing by type of test is given in Table 1. Guidance on testing options and methods for sample collection in primary care settings can also be found in Appendix 5.2.

Table 1. Summary of characteristics of microbiological tests for pertussis

Test method	Patient criteria	Sample type	Accessed via	Role of RVPBRU
Culture	Suspected cases in all age groups with cough <21 days duration	NPS/NPA/PNS	NHS laboratories, UKHSA Public Health Microbiology Clinical Network Laboratories	Confirmed isolates to be sent to RVPBRU
Serology	Suspected cases in older children or adults with cough >14 days [note 1] duration	Serum	Charged for service at RVPBRU	Samples tested and reported by RVPBRU
PCR	Suspected cases in all age groups with cough <21 days duration	NPS/PNS preferred; throat swab acceptable for community patients	UKHSA Public Health Microbiology Clinical Network Laboratories	Positive samples to be referred to RVPBRU

Test method	Patient criteria	Sample type	Accessed via	Role of RVPBRU
OF	Suspected cases aged 2 to <17 years with cough >14 days [note 1] duration	OF kit	OF kit sent to patient upon notification to UKHSA HPT	Samples tested and reported by RVPBRU

Note 1: Antibody levels confounded by recent vaccination. Recommended for those who have not received a dose of pertussis vaccine in the preceding year.

For the Bordetella reference services provided by the RVPBRU (pertussis serology; submission of *B.pertussis* isolates; submission of PCR positive respiratory specimens), the appropriate request form (currently UKHSA R3 Vaccine Preventable Bacteria Section) must be used. The request forms for the OF test (Appendix 5.3) are supplied with the testing kit. For the investigation of suspected outbreaks, or incidents of pertussis infection, RVPBRU can be contacted for advice on the most appropriate testing methods.

In interpreting the results of laboratory testing, the following should be borne in mind:

- given the limitations of **culture** methods, it is important to consider that a negative culture does not exclude pertussis
- because of the risk of confounding, **serological testing** should only be undertaken where there is a minimum of one year from primary or booster dose of pertussis containing vaccine and results should be interpreted with caution
- given that **oral fluid** testing is recommended only for children and young people at least 14 days from onset of cough, and that treatment and chemoprophylaxis is most effective when administered early, public health management of suspected cases and their contacts should not be delayed pending the availability of these test results, where appropriate clinical case definitions are met, as oral fluid testing is undertaken primarily for surveillance purposes

2.1.4 Case management

2.1.4.1 Exclusion

Individuals with suspected, epidemiologically linked, or confirmed pertussis should be excluded from work or school for 48 hours following commencement of recommended antibiotic therapy, or for 21 days following the onset of coughing if they are not being treated.

The following groups follow the same exclusion period but require extra precautions:

- **Healthcare workers** should inform their occupational health department and infection prevention control team as soon as possible – and should do so even if beyond 21 days from the onset of coughing as vulnerable contacts may still be within their incubation period

- **Hospital inpatients** should be placed in respiratory isolation until 48 hours of treatment is completed or for 21 days from onset if untreated

2.1.4.2 Antibiotic therapy for cases

The decision to offer antibiotics for pertussis cases, and the choice of treatment, is a clinical one. Ideally, antibiotics should be administered as soon as possible after onset of illness to eradicate the organism and limit ongoing transmission. The effect of treatment on reducing symptoms, however, is limited or lacking especially when given late during the disease. Antibiotics are not recommended or thought to be beneficial after three weeks of symptoms.

Details of recommended antibiotic treatment and chemoprophylaxis is given in Appendix 5.8. Clarithromycin is the preferred agent for use in infants below one month of age. Azithromycin may be used although there are limited data in this age group. Azithromycin and clarithromycin are the preferred antibiotics in children over one year and adults given the adverse effects associated with erythromycin. For individuals in whom macrolides are contra-indicated or not tolerated, co-trimoxazole may be used although this is not licensed in infants below 6 weeks of age.

Erythromycin is the preferred antibiotic for treating women in the last month of pregnancy to prevent ongoing transmission to their infant, with other macrolides as second and third line (see Appendix 5.8). For pregnant women, clinicians may wish to consult online guidance from the UK Teratology Information Service, where a decision needs to be made on antibiotic choice in the event that first-line therapy (erythromycin) cannot be used. Co-trimoxazole should not be used in pregnancy, particularly in the first trimester, unless no other antibiotic option is available.

2.1.4.3 Vaccination of cases

It is important that unvaccinated and partially immunised cases up to 10 years of age complete their course of primary immunisation and booster vaccine once they have recovered from their acute illness, following the UKHSA guidance document 'Vaccination of individuals with uncertain or incomplete immunisation status'.

Currently, routine immunisation against pertussis is not recommended for those aged ten years and over, except for pregnant women.

Pregnant women who have been diagnosed with pertussis (at any stage of pregnancy) and have not been vaccinated after 16 weeks of pregnancy, should be offered a dose of pertussis containing vaccine in line with national recommendations. Pregnant women diagnosed with pertussis before 16 weeks' gestation should wait until they reach 16 weeks of pregnancy (and ideally following the detailed ultrasound scan) to have the vaccine.

Certain HCW groups who have recovered from a primary infection should be offered a booster dose of pertussis-containing vaccine if they have not received a dose in the preceding 5 years, and no Td-IPV in the preceding month. Please refer to the guidance on occupational pertussis vaccination of healthcare workers for further information and advice on HCW vaccination.

2.2 Management of close contacts and post-exposure prophylaxis

2.2.1 Contact definitions

This section outlines definitions of close contacts for pertussis cases (suspected, confirmed or epidemiologically linked).

2.2.1.1 Households, outpatient healthcare and general community settings

The objective of contact tracing in households, healthcare and community settings is to reduce risk of exposure to vulnerable individuals meeting priority group definitions (see section 1.2.2), by reducing transmission of the organism in **the whole contact group**. Prolonged and close contact with a case during their infectious period is typically required for significant risk of pertussis transmission to arise.

Close contact in most settings is defined by prolonged (for example, overnight) contact with a case. Family members or people living in the same household as a pertussis case are considered close contacts, as would people in institutional settings staying overnight in the same room as a case during their infectious period (for example, in a boarding school). An exception to this contact definition in community settings concerns nursery workers and others working in childcare settings providing close personal care to infants meeting the priority Group 1 definitions set out in section 1.2.2, where a significant exposure would be defined as for healthcare workers (see below).

In most community settings, it is assumed that contact between a case and their contacts is continuous. Time since exposure would therefore be defined as the time since the onset of coughing in the index case, where the day of onset is set as day 0.

Other types of contact in the community would generally not be considered close enough for intervention to be effective.

2.2.1.3 Inpatient healthcare settings

As noted above, close contact in most settings is defined by prolonged (for example, overnight) contact with a case. Patients staying overnight in an inpatient setting with a pertussis case (for example, a hospital bay) would be considered close contacts by this definition. However, special considerations may apply if the case has occurred in a special healthcare setting (for example, SCBU). In these situations a broader contact definition may need to be applied depending on the outcome of risk assessment.

Other types of contact in healthcare settings (for example, at work, or in a hospital or GP surgery waiting room) would generally not be considered to constitute a close contact group where intervention would be effective.

2.2.1.3 Considerations for healthcare workers, and those working in nurseries and other childcare settings for infants

Special considerations apply to healthcare workers (HCWs), and those working in nurseries or other childcare settings, who provide close personal care to infants or pregnant women because of the nature of their interactions with vulnerable individuals meeting priority group definitions (see section 1.2.2). For exposed HCWs in priority group 2B and those falling into priority group 2C, the objective of contact tracing is to minimise the risk of further onward transmission to vulnerable individuals. For individuals in these categories, a significant exposure is defined as either:

1. Contact with a pertussis case within their own household.

Or:

2A. Direct, face-to-face contact (without appropriate PPE) in their place of work (for example, a healthcare setting or a nursery baby room) for greater than a cumulative period of one hour with a pertussis case who is within 21 days of the onset of their cough.

Or:

2B. Direct contact with respiratory secretions from a pertussis case within 21 days of onset of their cough (for example, when performing aerosol-generated procedures or examination of the nose and throat in a healthcare setting without appropriate personal protective equipment (PPE); or exposure to infectious respiratory particles from case with active coughing at less than 2 metre distance).

For HCWs, prolonged contact at close proximity of the kind described in 2A above is more likely to occur in inpatient settings than in outpatient settings, primary or ambulatory care, but risk assessment may be required where vulnerable (unimmunised or partially immunised) infants are concerned. Close contact of type 2A above may also occur in nursery or childcare settings depending on the kind of work involved.

For those in relevant places of work, close contact is likely to occur through either a single exposure, or on an intermittent basis. Time since exposure is therefore defined as the time that has elapsed since the most recent exposure to the index case, where the day of the most recent exposure is defined as day 0.

2.2.2 Contact management

2.2.2.1 Exclusion

Exclusion for asymptomatic contacts is **not** required.

2.2.2.2 Chemoprophylaxis of contacts

General recommendations

Given the limited benefit of chemoprophylaxis, antibiotic prophylaxis should only be offered to close contacts when both of the following conditions apply:

- onset of disease in the index case is within the preceding 21 days **and**
- there is a close contact in one of the priority groups as defined above in section 1.2.2

Where both these conditions are met, all close contacts of a confirmed case (regardless of age and previous immunisation history) should be offered chemoprophylaxis. The dose of antibiotics for use as chemoprophylaxis is the same as for the treatment of cases (see Appendix 5.8). Chemoprophylaxis is not required where there are no close contacts in the priority groups in section 1.2.2. Chemoprophylaxis is not required if the case is the only household member who falls into a priority group.

Regarding the choice of antimicrobial for chemoprophylaxis, pregnant women exposed after 32 weeks pregnancy (Group 2A) should be offered erythromycin, if they have not received a pertussis containing vaccine within the past five years. For pregnant women, HPTs or clinicians may wish to consult online guidance from the UK Teratology Information Service, where a decision needs to be made on antibiotic choice in the event that first-line therapy (erythromycin) cannot be used. For pregnant contacts who have received a pertussis containing vaccine within the past one week, chemoprophylaxis would still be indicated given the delay in antibody response. For individuals who fall into priority groups 2B, 2C or 2D who happen to be pregnant as well, chemoprophylaxis and vaccine is recommended at any stage of pregnancy. A further dose of pertussis containing vaccine will be required after 16 weeks of pregnancy.

For pregnant women with suspected or confirmed pertussis, who are still infectious at delivery (that is, within 21 days of onset), the newborn infant should be offered chemoprophylaxis with clarithromycin (first-line) or second- or third-line options as outlined in Appendix 5.8 regardless of the mother's vaccination status.

Contacts in special healthcare settings

If a risk is deemed to exist in a setting such as PICU or SCBU, given the vulnerability of the patient population, prophylaxis is recommended for infants specified in the vulnerable groups defined in section 1.2.2 within the same bay as the case (regardless of the duration of exposure).

Chemoprophylaxis and/or vaccination should be offered to those meeting priority group definitions. Any other contacts identified that had significant exposure but are not in priority groups, do not need prophylaxis. They should be informed and advised to seek early medical advice if symptoms appear, using the relevant template letter from Appendix 5.7.

There may also be complex questions arising from exposures in the NICU setting given the vulnerability of the patient population and nature of HCW contacts. A range of additional considerations may include the role of chemoprophylaxis for new admissions and the scheduling of the first dose of vaccines for infants on NICU. For further advice, please discuss with colleagues in the Immunisation and Vaccine Preventable Disease Division (IVPD), UKHSA Colindale.

Contacts of a HCW, nursery worker or childcare worker case

Chemoprophylaxis should be offered to contacts of a HCW, nursery worker or childcare worker case in the following groups where there has been a significant exposure during the infectious period of the index case (up to 21 days from onset of cough) and prophylaxis can be given within 21 days of last exposure:

(i) vulnerable infants in Group 1 as set out above
(ii) pregnant women who have reached 32 weeks gestation but have either not received a booster dose of pertussis-containing vaccine within the past 5 years, or received a pertussis-containing vaccine within the previous week
(iii) healthcare worker, or nursery or childcare worker contacts who provide close personal care to infants in Group 1 or pregnant women, and who have not received a booster dose of pertussis-containing vaccine more than 1 week and less than 5 years ago

2.2.2.3 Vaccination of contacts

Recommendations regarding immunisation of contacts who have been offered chemoprophylaxis are as follows:

(i) unimmunised and partially immunised contacts up to the age of 10 years should complete the schedule with the appropriate vaccine, in accordance with guidance on vaccination of individuals with uncertain or incomplete vaccination status
(ii) a booster dose of pertussis containing vaccine is recommended to all household contacts aged 10 years or older, who have not received a dose of pertussis-containing vaccine in the last 5 years and no Td-IPV vaccine in the preceding month
(iii) any pregnant contacts who have reached or passed the 16th week of their pregnancy but have not yet received a pertussis-containing vaccine during their current pregnancy should be vaccinated, ideally following the detailed ultrasound scan
(iv) for contacts who are healthcare workers and provide close, personal care to infants in Group 1 or pregnant women, a booster dose of pertussis-containing vaccine is recommended if they have not received a dose in the preceding 5 years, and no Td-IPV in the preceding month

3. Specific settings and situations

This section outlines recommended actions in the event of probable or confirmed outbreaks of pertussis in healthcare or educational settings.

3.1 Healthcare settings

As elsewhere, the primary objective of public health action in healthcare settings is to protect young infants who are not fully protected by vaccination from severe disease and death. As protection following vaccination wanes over time, susceptible adults in the population can be an important source of infection for these infants, and for pregnant women who are themselves most likely to have close contact with vulnerable infants. The priority in healthcare settings is case finding and therefore in these circumstances a less specific case definition should be used; a low threshold is recommended for referral of symptomatic contacts to a clinician for assessment, and for reporting to the IPCT.

3.1.1 Outbreak confirmation

In the event of a suspected outbreak, attempts should be made to confirm diagnosis following discussion with the Respiratory and Vaccine Preventable Bacteria Reference Unit (RVPBRU), UKHSA Colindale (020 8327 7887).

3.1.2 Role of the incident management team, and formal risk assessment

Where 2 or more suspected, confirmed or epidemiologically linked cases of pertussis occur in a healthcare setting, an incident management team (IMT) should be convened. This is likely to include:

- director of infection prevention and control
- hospital microbiologist (if different)
- infection control nurse
- consultants from relevant clinical specialties
- occupational health physician or nurse
- HPT representative
- screening and Immunisation team representative
- communications

IMT risk assessment should consider the following:

1. Are any of the cases confirmed?
2. Is transmission likely to have occurred in the healthcare setting or in the community?
3. Is the transmission from HCW to HCW/HCW to patient/or patient to HCW?

4. What was the nature of contact between the cases?
5. Is there a risk of ongoing transmission in the setting?

NHS providers should seek advice from their local Infection prevention and control (IPC) team. In addition, expert advice on outbreak investigation and response is available from the Immunisation and Vaccine Preventable Diseases (IVPD) division, UKHSA Colindale (immunisation.lead@ukhsa.gov.uk) and on laboratory investigation from the Respiratory and Vaccine Preventable Bacterial Reference Unit (RVPBRU), UKHSA Colindale (020 8327 7887).

3.1.3 General management considerations

Once a risk assessment has been carried out, onward management of cases and contacts should proceed in line with the approach set out in section 2 of this guidance.

3.1.4 Communications

Pertussis remains a notifiable disease under the Health Protection Legislation (England) Guidance 2010, and suspected cases should be notified to the local HPT. This should be done by telephone as soon as is practicable and in writing within 3 days.

Aside from standard surveillance requirements outlined in section 1.3, HPTs are requested to notify the IVPD division of any suspected or confirmed outbreaks in healthcare settings by submitting the relevant reporting form (see Appendix 5.6) to pertussis@ukhsa.gov.uk.

Staff should report infections to Occupational Health (OH) and the relevant Infection prevention and control team (IPCT) should be informed of any cases of pertussis occurring in healthcare settings. All contacts identified with significant exposure should be informed and advised of symptoms to enable early detection of illness. The IPCT/OH will need to undertake passive surveillance amongst staff and patients to ensure early detection and management of any further cases. This would normally be for a period of 42 days (2 incubation periods) from onset of symptoms in the index case.

3.1.5 Vaccination of healthcare workers

Susceptible adults working in healthcare settings pose a potential risk of transmission to vulnerable infants and incidents in healthcare settings can be both challenging and resource intensive to manage. Vaccination of HCWs with pertussis vaccine can help prevent nosocomial transmission to infants. In 2016, the Joint Committee on Vaccination and Immunisation (JCVI) advised that HCWs with direct contact with vulnerable patients (pregnant women and/or infants) are priority groups for immunisation. Please refer to the guidance on occupational pertussis vaccination of healthcare workers for further information and advice on HCW vaccination.

3.2 Childcare and educational settings

As elsewhere, the primary objective of public health action in childcare and educational settings is to protect young infants who are not fully protected by vaccination from severe disease and death. There may be additional considerations in these settings, however, depending on:

- time since completion of the primary vaccination course for pertussis (in light of evidence of waning of protection over time)
- the closeness of contact between suspected or confirmed cases and others in institutional settings such as boarding schools

3.2.1 Outbreak confirmation

In the event of a suspected outbreak in a nursery or educational setting, the priority is to confirm the diagnosis and improve case finding. Potential cases should be referred to relevant healthcare services for clinical assessment and laboratory testing as appropriate.

3.2.2 Role of the incident management team, and formal risk assessment

If 2 or more confirmed and epidemiologically linked cases of pertussis occur within 42 days of each other an incident management team (IMT) may be considered. In high-risk settings such as residential or SEND education settings there might be a more significant need for an IMT than in mainstream settings. A risk assessment should be undertaken by the IMT to determine whether further public health action should be undertaken.

The IMT should consider the following to inform their risk assessment:

- how many cases are confirmed?
- what is the severity of illness in the cases?
- is transmission likely to have already occurred?
- what was the nature of contact between the cases?
- is there a risk of ongoing transmission in the setting?
- what is the duration of the outbreak and thus the likely benefit of widespread chemoprophylaxis and/or vaccination?
- is there a clearly defined group who can be identified for chemoprophylaxis and/or vaccination?
- how practical and feasible is widespread chemoprophylaxis and/or vaccination?
- how acceptable is widespread chemoprophylaxis and/or vaccination?
- how likely are parents or guardians and staff to comply with advice?
- what is the degree of parental and or staff anxiety?
- what is the age of potential contacts and how vulnerable are potential contacts to significant illness because of pertussis infection?
- what is the level of pre-existing vaccination coverage amongst children and staff?

- are there impending events or holidays which may act to facilitate or interrupt transmission?

3.2.3 Management under different scenarios

Once a determination of risks for the outbreak concerned has been made, onward management of cases and contacts should proceed in line with the approach set out in section 2 of this guidance. However, the following scenarios outline in more detail approaches to management of outbreaks depending on the type of educational setting concerned.

Outbreak scenario 1: 2 or more cases in a nursery

This scenario outlines actions in a nursery setting in which 2 or more confirmed, or at least one confirmed and one clinically suspected, cases of pertussis have been documented within a 42-day period, and where transmission is likely to have occurred within the nursery.

Chemoprophylaxis: it may be appropriate to consider more widespread chemoprophylaxis (for staff and children) than recommended in section 2.2 above, depending on the severity of illness among those affected, the number of cases and the number of potential contacts, in addition to the age and vaccination status of those exposed. In settings with a large proportion of incompletely vaccinated infants, the IMT may consider arranging chemoprophylaxis if a clearly defined group can be identified and it is practical and feasible (see Appendix 5.8 for recommended antibiotic regimen).

Vaccination: the IMT should advise that all nursery attendees (and their siblings) and staff check that they are up to date with their pertussis vaccinations and if not, arrange an appointment with their GP promptly to catch up on missing doses. Given the age group, widespread booster vaccinations are unlikely to be required in this setting. Pregnant nursery staff should be advised to follow routine advice in relation to pertussis vaccination in pregnancy (advised from 16 weeks of pregnancy) and to discuss any specific concerns with their midwife.

Outbreak scenario 2: primary (day) school

This scenario outlines actions in a primary (day) school setting in which 2 or more confirmed, or at least one confirmed and one clinically suspected, cases of pertussis have been documented within a 42-day period, and where transmission is likely to have occurred within the setting.

Chemoprophylaxis: this is not routinely recommended in this setting except in exceptional circumstances. Chemoprophylaxis may be considered when the uptake of the routine childhood vaccinations in the cohort at risk is known to be particularly low (based on local immunisation coverage data).

Vaccination: an offer of booster vaccination may be considered based on the following factors: severity of cases, numbers of children affected, presence of a significant number of vulnerable contacts, and low background vaccination coverage. In this situation, the IMT may decide to offer a booster dose to all children or advise that parents or guardians ensure that all children are up to date with the national vaccination schedule by checking with their GPs.

Outbreak scenario 3: secondary (day) school

This scenario outlines actions in a secondary (day) school setting in which 2 or more confirmed, or at least one confirmed and one clinically suspected, cases of pertussis have been documented within a 42 day period, and where transmission is likely to have occurred within the setting.

Chemoprophylaxis: this is not routinely recommended in this setting.

Vaccination: in this situation, it is assumed that all students are likely to be at risk of developing infection given the waning immunity from the vaccine that is frequently observed in this age group. However, there is a low likelihood of severe disease and students of this age may also be less likely to have close contact with those perceived to be more vulnerable to severe pertussis (unvaccinated infants and pregnant women who may transmit to unvaccinated infants, see section 1.2.2).

Therefore, widespread vaccination would not be routinely recommended. However, if there were high numbers of hospitalisations, or significantly large numbers of students affected, the IMT might consider booster vaccination as a control measure. Use of the relevant template letter accompanying this guidance (see Appendix 5.7) to encourage students, parents or guardians to ensure children are up to date with their routine childhood vaccinations is recommended.

Outbreak scenario 4: boarding school

This scenario outlines actions in a boarding school setting in which 2 or more confirmed, or at least one confirmed and one clinically suspected, cases of pertussis have been documented within a 42-day period, and where transmission is likely to have occurred within the setting.

Chemoprophylaxis: Consideration needs to be given to whether the boarding school environment is equivalent to a household setting. For example, pupils staying overnight in the same room as a confirmed pertussis case in a boarding school setting would be defined as close contacts in accordance with current national guidance. In this case, chemoprophylaxis would need to be provided as per household contacts detailed in section 2. It may also be worth potentially extending this to specific relevant cohorts such as boarding houses for protracted outbreaks.

Vaccination: this is likely to be recommended, but the IMT need to consider the age group affected and timing of school age routine booster vaccine as to whether this is in the form of a mass booster campaign or a catch-up programme. The rationale for this approach is that the outbreak is likely to be protracted and a closed setting means it is perceived to be beneficial to interrupt transmission with potentially large numbers of students affected. However, this may be guided by consideration of the feasibility or practicality, and acceptability or compliance with this approach in addition to the degree of parental and or staff anxiety and any impending events or holidays which may act to facilitate or interrupt transmission.

3.2.4 Communications

The need to share information within UKHSA and with external partners should be considered and may be guided by the input of regional UKHSA communications colleagues.

The following actions should also be considered:

- providing the UKHSA guidance 'Health protection in schools and other childcare facilities to the educational setting'. This guidance contains advice in relation to generic respiratory infection prevention and control (IPC) measures which are effective in limiting the spread of respiratory infections
- providing warn and inform advice to parents or guardians (template letters accompany this guidance in Appendix 5.7). In addition to providing routine advice regarding exclusion, early assessment for symptoms and vaccination, the IMT may choose to include advice regarding what to do if attending hospital appointments or primary care and requirements of close contacts who are healthcare workers to consider informing their occupational health teams
- drafting a reactive media statement
- informing local healthcare services on case reporting and management recommendations
- informing the local authority public health team
- informing UKHSA national immunisation team at immunisation.lead@ukhsa.gov.uk
- informing relevant UKHSA laboratories (regional and national) and NHS Laboratories
- liaising early with NHS immunisation services to ascertain and improve vaccination coverage in the at-risk population
- liaising early with field epidemiology colleagues to monitor the epidemiology of the outbreak

3.2.5 Ongoing surveillance

The HPT will also need to advise the school and local healthcare services about passive surveillance amongst staff and children to ensure early detection and management of any further cases.

If further clinically suspected cases arise during the surveillance period (42 days from onset of index case), mass testing may be discussed as part of the IMT. Advice on laboratory testing and interpretation may also be sought from the Pertussis Reference Laboratory, Respiratory and Vaccine Preventable Bacteria Reference Unit (RVPBRU), UKHSA Colindale (020 8327 7887). However, public health action including exclusion and treatment of cases should proceed based on clinical diagnosis.

3.3 Considerations for managing pertussis during periods of high activity

The guidelines above provide detailed public health advice on the risk assessment of suspected and confirmed cases and the management of their contacts.

During periods of high incidence, where there is established widespread transmission, capacity to undertake this degree of follow-up for individual cases and their contacts will be limited and will have little public health benefit. The considerations below outline potential approaches that may be adopted in the event of future high activity periods. Periods of high incidence will be identified through national risk assessment, similar to the approach taken during the 2012 and 2024 activity peaks.

3.3.1 Exclusion of cases

The risk of onward transmission from an untreated case declines over time. During periods of high activity, when asymptomatic infection is likely to be widespread, exclusion beyond 14 days to prevent ongoing transmission is unlikely to have a significant impact at a population level in the majority of cases, except where there are known vulnerable close contacts identified. Therefore, in periods of high activity, the exclusion period could be reduced in the following groups with suspected, epidemiologically linked or confirmed pertussis:

- children may be excluded from schools or nurseries for 48 hours following commencement of recommended antibiotic therapy, or for 14 days following the onset of coughing if they are not being treated
- staff in nursery and childcare settings, in schools and in other educational settings who **do not** provide close personal care to children in priority Group 1 may be excluded for 48 hours following commencement of recommended antibiotic therapy, or for 14 days following the onset of cough if untreated

3.3.2 Antibiotic therapy for cases

The benefit of antibiotics on the clinical course of the illness is limited to the early catarrhal phase. Beyond the first 14 days, the main benefit of antibiotic therapy is to reduce transmission to close contacts. During periods of high activity, when asymptomatic infection is likely to be widespread, the use of antibiotics in cases beyond 14 days to prevent ongoing transmission is

unlikely to have a significant impact at a population level. Therefore, in periods of high activity, the following considerations may apply:

- antibiotic therapy can be considered for clinical indications within 14 days of onset of cough
- however, where the case has a household or other close contact who falls into priority Group 1 for public health action or is a pregnant woman, antibiotic therapy may be warranted for all cases commencing within 21 days of onset of cough

The second bullet above would apply, for example, to cases who are healthcare workers providing close personal care to infants or pregnant women, or nursery workers providing close personal care to infants in a baby room that includes children under 3 months of age.

3.3.3 Chemoprophylaxis for contacts

In all settings, chemoprophylaxis is more effective the earlier it is administered post-exposure. In household settings the benefit of chemoprophylaxis declines over time following the onset of coughing in the index case. Therefore, during periods of heightened transmission, when transmission is widespread, chemoprophylaxis for contacts beyond 14 days from the point of exposure may be limited and not recommended. Where cases and outbreaks occur in settings where it is unlikely that those exposed will be members of a priority group (for example, school settings) investigation and active intervention may not be routinely recommended.

4. Evidence for guidance recommendations

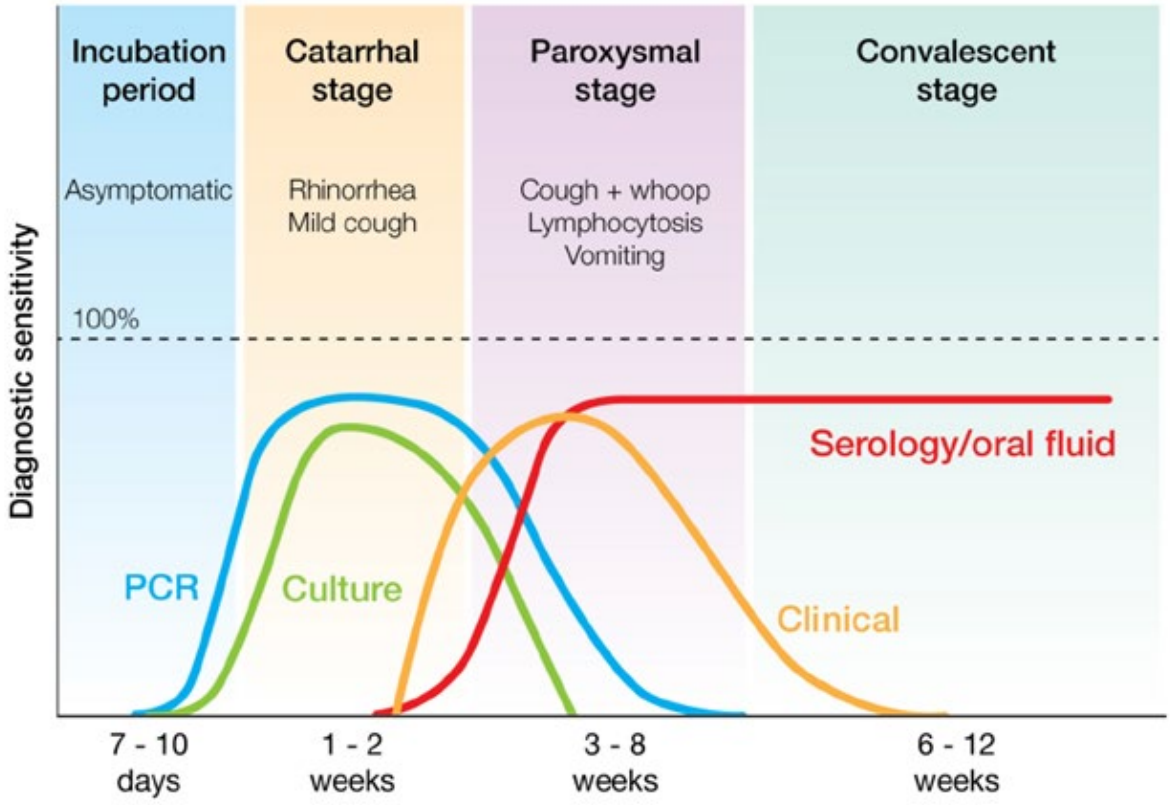
4.1 Laboratory investigation of pertussis

Laboratory confirmation of clinically suspected cases can be made by one of 4 methods:

- culture and isolation of the causative organism, *B. pertussis*
- detection of its DNA (from nasopharyngeal swabs (NPS)/pernasal swabs (PNS) or nasopharyngeal aspirates (NPA) or throat swabs
- antibody detection performed on serum
- antibody detection performed on oral fluid

The strengths and limitations of each of the laboratory methods are discussed in detail below, but there are important variations in the effectiveness of different modalities in supporting diagnosis depending on time from infection. Figure 1 provides an overview of these time intervals.

Figure 1. Diagnostic sensitivity by test type as assessed from time of infection



Source: Fry NK, Campbell H, Amirthalingam G. 'JMM Profile: Bordetella pertussis and whooping cough (pertussis): still a significant cause of infant morbidity and mortality, but vaccine-preventable' Journal of Medical Microbiology 2021: volume 70, issue 10, page 001442. doi: 10.1099/jmm.0.001442. PMID: 34668853; PMCID: PMC8604168.

4.1.1 Culture

Laboratory confirmation is conventionally performed by culture and isolation of B. pertussis from NPA or NPS/PNS. Where local laboratory facilities are available, culture should be attempted as isolation of the causative organism is definitive and characterisation of isolates is important for further surveillance of circulating strains.

It is important to note that B. pertussis is a delicate organism and therefore, processing delays may affect the likelihood of a positive culture. Sensitivity is also highly dependent on specimen quality and is affected by increasing patient age, vaccination status and length of illness. The likelihood of a positive culture also decreases with time after onset, from approximately 60% within one week of symptom onset to culture to 10% or less after 4 weeks (19, 20). Cultures are unlikely to be positive in adolescents and adults with more than 3 weeks of coughing (21).

It is also more difficult to recover the organism in vaccinated compared with unvaccinated children (22). Given the limitations of culture methods, it is important to emphasise that a negative culture does not exclude pertussis.

4.1.2 Bacterial genome detection by real-time PCR

PCR can also be performed on NPA or NPS/PNS samples to detect *B. pertussis* genomic DNA as it has been shown to have improved sensitivity over culture and laboratories often find it simpler to perform, it has become more widely offered than culture (21). Samples can be referred to UKHSA laboratories for testing, but many local hospitals now offer the test, particularly due to the increasing availability of multiplex respiratory panel testing, where such panels include *B. pertussis*. This may lead to greater case ascertainment. Since 2014, regional UKHSA laboratories have offered a pertussis PCR service for patients in all age groups in both hospital and primary care settings.

PCRs directed against *B. pertussis* generally adopt one of 2 strategies:

- they may be directed at the insertion element IS*481* which is present in multiple copies in *B. pertussis* (and so increases the test's sensitivity), but is also present in some other *Bordetella* species – that is, *B. holmesii* and some, but not all, *B. bronchiseptica* (23, 24). Even though the specificity of this target is not 100%, a positive result is most likely due to *B. pertussis* rather than one of the other rarer species. (A laboratory report should include a caveat explaining that this PCR target is present in other *Bordetella* species)
- they may be directed against a gene target that is only present in the genome in a single copy, and so the test is less sensitive but is 100% specific for *B. pertussis* (for example, the pertussis toxin promoter region (*ptxP*)) (no caveat is necessary when reporting a positive result)

Some in-house and commercial PCR kits use a combination of both of these by using two gene targets to maximise both sensitivity and specificity.

PCR is usually more sensitive than culture as the organism does not need to be viable. However, its sensitivity also decreases with time after onset and PCR is less likely to be positive in patients with symptom duration of 21 days or more. The method of sampling is also important. A PHE pilot comparing the use of nasopharyngeal swab (NPS) and throat swabs in primary care for pertussis PCR found throat swabs to be an acceptable alternative. While NPS are preferable for PCR testing, throat swabs may be used if NPS are not available, especially in community settings.

4.1.3 Serology

Detection of anti-pertussis toxin (PT) IgG antibody levels in serum taken at least fourteen days after the onset of cough using an enzyme linked immunosorbent-assay (ELISA) can provide confirmatory evidence of recent infection. Serology may be particularly helpful to confirm the diagnosis of pertussis in patients with a cough duration of 21 days or more, when culture and PCR are unlikely to yield positive results. Testing has become more widely offered by UKHSA and local laboratories in the last few years and any test that is detecting anti-PT IgG and reporting in International Units per ml (IU/ml) with a diagnostic threshold value between 50 and 125 IU/ml should give a reliable indication of a recent pertussis infection (25). There are 2 caveats to a positive result: immunisation against pertussis within the last year or a previous positive serological diagnosis within the last year can generate a false positive result. In addition, a negative result from a serum sample taken before the patient had been coughing for 14 days may be a false negative result. The anti-PT IgG serology test cannot be used to determine immunity as there are currently no agreed correlates of protection.

A charged-for serology service is offered by RVPBRU, which defines a serologically confirmed case as an anti-PT IgG concentration >70 IU/ml in the absence of recent vaccination (within the past year) (26). This serological assay is targeted towards older children and adults. Interpretation of anti-PT IgG levels among infants and younger children may be confounded by the presence of maternal antibodies or recent primary and booster vaccination, or show an atypical response.

Data using the RVPBRU test suggests that the confounding period following vaccination may be up to 10 months after the primary vaccination and up to 3 years or more after the preschool booster (27). Therefore, serological testing should only be undertaken where there is a minimum of one year from primary or booster dose of pertussis containing vaccine and results should be interpreted with caution.

4.1.4 Oral fluid testing

An oral fluid (OF) antibody test detecting anti-PT IgG was created by UKHSA as a surrogate for the serology test and has a diagnostic threshold of 70 arbitrary units (aU), which is equivalent to

a serum threshold of 70 IU/ml (29, 32). A national oral fluid (OF) testing service for the detection of anti-pT IgG was first made available in England in 2013, following a successful pilot which suggested a 32% increase in confirmation of probable cases (with a particular benefit amongst 5 to 9 year olds) (28, 29). Since May 2018, this through-the-post OF testing service has been available for all cases of probable whooping cough aged between 2 and 16 years, notified to HPTs, where the case has not had a pertussis containing vaccine in the previous year. An OF kit should be sent out following notification of a suspected case in the target age group.

The OF assay is slightly less sensitive (93%) than the serological assay (27), but enables better case ascertainment and confirmation in an age group where serology testing is unlikely to be performed. The service provides a vital surveillance role amongst the target age groups. It is only available via RVPBRU.

The OF test offers practical and clinical advantages to confirm suspected cases in pertussis outbreaks but HPTs are required to discuss this with RVPBRU before use in outbreak situations. In addition, given that routine OF testing is recommended only for children and young people with a history of at least 14 days of cough, and that the benefits of treatment for suspected pertussis are greatest where initiated as soon as possible after illness onset, public health management of suspected cases and their contacts should not be delayed pending the availability of OF test results, where appropriate case definitions are met.

As OFK is used for surveillance, it remains worthwhile to collect an oral fluid sample for up to a year after cough onset, since patients with an initial positive titre may continue to yield positive results.

4.2 Groups at greatest risk of severe or complicated pertussis

4.2.1 Group 1: individuals at increased risk of severe complications (‘vulnerable’)

Young, unimmunised infants (particularly those prematurely born, under three months of age, or born to unimmunised mothers) (30) are at greatest risk of severe complications, hospitalisation and death following *B. pertussis* infection. Partially immunised infants are not fully protected, although disease severity may be reduced. In a study of 201 hospitalised infants (under 6 months of age), the median duration of hospitalisation was significantly shorter (4 versus 11 days; p=0.03) for those who had received at least one dose of vaccine previously, when compared with those who were unimmunised (31).

Serious complications such as pneumonia, syncope and rib fracture can occur in older individuals but there is little evidence to suggest that any specific clinical groups are at increased risk of pertussis or its complications (32 to 34). Pregnant women are not considered at increased risk of severe disease compared with non-pregnant women. The relative

immunosuppression of pregnant women to viral disease in the third trimester does not appear to be replicated with bacterial infections such as *B. pertussis* (35), although symptoms in late pregnancy may be more intense due to constraints on pulmonary function.

Current evidence suggests that immunocompromised individuals are not at higher risk of complications from pertussis (36). Those with underlying immunosuppression may be less likely to mount a sufficient immune response to vaccination (37) but there is little evidence of increased severity of illness (single case reports only) (38 to 40). A number of case studies have also described prolonged illness in patients with HIV infection (41 to 43) but pertussis infection among HIV infected individuals is again not thought to be particularly common. It might be expected that some underlying long-term conditions, such as asthma, congestive heart failure or chronic obstructive pulmonary disease, would exacerbate illness following pertussis infection, but there is currently no conclusive evidence to support this (44 to 46).

4.1.2 Group 2: individuals at increased risk of transmitting to 'vulnerable' individuals in 'group 1' if they have pertussis

4.1.2.1 Pregnant women

Parents and particularly mothers are found to be a frequent and important source of pertussis infection amongst young infants (54 to 58). In a US study of infants with reported pertussis, over 70% had been infected by their mother or another family member, the majority of whom were aged 20 years or more (59). A further study of infants admitted to a UK paediatric intensive care unit with respiratory complications, demonstrated that 20% had laboratory evidence of pertussis and half of these were infected from an adult family member (60). Data from the previous national outbreak in England identified mothers as the source of infection in 38% of confirmed infant cases during 2012, where a source was known (unpublished data). Women in the later stages of pregnancy may be at particular risk of transmitting pertussis to newborn infants. Although pertussis in pregnant women is not thought to be more severe than in other adults, and no obstetric or foetal adverse outcomes have been described (50), mother to infant transmission at the time of, or shortly after, birth has been described (61, 62) and is often associated with severe neonatal illness (63 to 65). In a Dutch study of 201 infants hospitalised with pertussis 46 (23%) of the index cases were mothers, of whom 14 (22%) had onset of symptoms during pregnancy (37).

4.1.2.2 Healthcare workers

In addition to parents, other adults in close contact with vulnerable young infants including healthcare workers may be responsible for transmission (67). Serological studies suggest that infection in healthcare workers can be frequent, but often unrecognised (68). Outbreaks in healthcare settings may be prolonged due to waning immunity in adults, with multiple opportunities for secondary and tertiary transmission. Likely transmission from healthcare worker to patient and vice versa has frequently been described (70 to 73) although the greatest risk of nosocomial transmission is likely to be from a healthcare worker to a patient or other member of staff. A 5-year analysis of clusters of pertussis infection in France revealed that the

most frequent reports of healthcare associated clusters were from paediatric, maternity and neonatal units (74).

4.3 Exclusion of cases

4.3.1 Exclusion period for cases after antibiotic initiation

Studies assessing the time to nasopharyngeal clearance after initiating antibiotic therapy provide important evidence to inform exclusion periods. Although most available studies measure clearance at the end of treatment rather than at early intervals, several investigations have evaluated early microbiological response. A prospective open label study reported a 97% clearance rate by days 2 to 3 following azithromycin initiation (47), and 2 human challenge studies showed clearance by day 2, with rates of 71 to 88% (48, 49). A 48-hour exclusion period after commencing recommended antibiotics was considered proportionate and appropriate based on the review of these data by microbiology specialists. Taken together, these findings indicate that infectivity is substantially reduced within the first two days of therapy, supporting the use of a 48-hour exclusion period following the start of antibiotic treatment.

4.4 Antibiotics for pertussis case management and post-exposure prophylaxis

UK guidelines published in 2002 recommend chemoprophylaxis with erythromycin in households with vulnerable contacts within 21 days from the onset of disease (50). Prior to the widespread use of newer macrolides, erythromycin was recommended as the drug of choice for the prophylaxis and treatment of pertussis, except for infants below one month. Erythromycin has a limited effect in improving the clinical course of the illness especially if administered beyond 2 to 3 weeks after the onset of symptoms. Treatment is therefore primarily aimed at eradicating B. pertussis from cases and preventing secondary transmission. However, studies investigating the use of antibiotics for preventing onward transmission have only demonstrated efficacy if treatment is given within 7 to 14 days of onset of illness (51 to 53). Erythromycin is poorly tolerated, causing gastrointestinal side-effects in up to 30% of patients (54, 55) which may lead to non-compliance with therapy (50).

As a result, the use of chemoprophylaxis in the UK has been limited to households with vulnerable contacts where the risk of severe complications and/or ongoing transmission is high (1). This compares with the US approach of recommending more widespread use of chemoprophylaxis to all household contacts and other close contacts regardless of age and immunisation status (56).

4.4.1 Treatment of suspected cases

A Cochrane systematic review of antibiotics for pertussis concluded that although antibiotic therapy for cases was effective in eliminating B. pertussis, it did not alter the subsequent clinical

course of the illness (57). Short-term antibiotics (azithromycin for 3 to 5 days; clarithromycin or erythromycin for 7 days) were as effective as long term (erythromycin for 10 to 14 days) in eradicating B. pertussis from the nasopharynx (RR 1.02, 95% CI 0.98, 1.05) but had fewer side-effects (RR 0.66, 95% CI 0.52, 0.83). Since publication of the Cochrane review, more recent studies have demonstrated that early treatment of cases (within 7 to 14 days of onset) can prevent onward transmission (51 to 53).

Newer macrolides such as azithromycin and clarithromycin are now the preferred choice for the treatment and prophylaxis of pertussis, with clarithromycin being the preferred antibiotic for use in neonates. Both antibiotics offer the advantages of improved absorption, a longer half-life, good in vitro activity against B. pertussis and a better side-effect profile (66). In addition, these agents involve less frequent dosing and shorter duration of therapy. A number of studies have established the safety and efficacy of newer macrolides for eradicating B. pertussis (58, 59). The improved side-effect profile has also been shown to improve compliance with treatment (60).

Prior to 1994, erythromycin resistance in B. pertussis was not observed, but since then resistance has been reported in a number of countries worldwide (61 to 65). From 2001 to 2009, UK B. pertussis isolates were tested against three agents, erythromycin, clarithromycin and azithromycin and all isolates (n=583) were found to be fully susceptible to all three agents tested (66). More recently, testing of isolates spanning the period 2013 to 2024 (n=661 in total, of which n=430 were from the period of the pertussis outbreak in 2023 to 2024) identified 2 samples with genotypic and phenotypic evidence of macrolide resistance.

For those patients where a macrolide is contra-indicated or is not tolerated, co- trimoxazole is effective in eradicating B. pertussis from the nasopharynx and can serve as an alternative agent, although it is unlicensed for chemoprophylaxis and is not recommended in pregnancy (57, 67, 68).

4.4.2 Prophylaxis for close contacts

The Cochrane review referenced above also concluded that there was insufficient evidence to determine the benefit of prophylactic treatment of pertussis contacts (57). In the 2 trials included in the review, which investigated the effectiveness of chemoprophylaxis with erythromycin, clinical symptoms in the treatment group were slightly less severe (not statistically significant) than the placebo group (55, 69). The number of contacts that became culture-positive were less in the erythromycin group (3 out of 142, 2.1%) compared to placebo (8 out of 158, 5.1%) but this difference was not statistically significant (RR 0.42; 95% CI 0.11, 1.54) (55).

Alvarez and colleagues analysed 476 index patients and 1,975 household contacts during a pertussis outbreak in Spain (2012 to 2013) (70). Compared with contacts who did not receive chemoprophylaxis, effectiveness was 82.3% (95% CI 39.1 to 94.9) when administered within seven days, 46.4% (95% CI – 8.1 to 73.4) when given within 8 to 14 days, and only 11.8% (95% CI – 71.5 to 54.6) when initiated within 15 to 21 days.

In summary, evidence on the effectiveness of post-exposure chemoprophylaxis for contacts is limited in general and especially for new macrolides, but suggests that timing – and particularly administration within 14 days of symptom onset – is important in determining outcome. In practical terms, whilst early administration may improve the efficacy of chemoprophylaxis in preventing secondary transmission, this requires a clinical diagnosis, which is likely to be a challenge given that adolescents and adults who are often the source of infection, generally do not seek timely health advice.

4.4.3 Use of antibiotics in pregnant women

Although there is no evidence of harm, avoidance of all drugs in the first trimester of pregnancy is generally advised (71). Erythromycin may be offered to treat women early in pregnancy but this is only likely to be of any clinical benefit if it can be administered in the early stages of the illness. For women diagnosed with pertussis in the last month of pregnancy, erythromycin is recommended to prevent transmission to her infant. Potential concerns regarding an association between maternal erythromycin therapy (in late pregnancy) and infant hypertrophic pyloric stenosis have largely been refuted (72 to 74). Therefore, while these guidelines recommend the use of erythromycin to treat cases in the last month of pregnancy, its use in earlier stages of pregnancy should be a clinical decision based on the likely clinical benefit for the woman and the presence of any vulnerable close contacts.

Antibiotics are also recommended for women exposed during pregnancy. In these circumstances, chemoprophylaxis is only recommended for women exposed after 32 weeks of pregnancy, who have either not received a pertussis-containing vaccine within the past 5 years, or received a pertussis-containing vaccine within the previous week. Since the introduction of the temporary maternal vaccination programme in England, coverage has been consistently above 50%, peaking at over 70% in year 2019 to 2020 (75). Therefore, many pregnant women exposed after 32 weeks are likely to have received the vaccine and will not require chemoprophylaxis. Given that it takes at least one week to develop an antibody response from a pertussis booster dose in adults, pregnant contacts (32 or more weeks gestation) who have received a pertussis containing vaccine within the past one week will still require chemoprophylaxis.

4.5 Post-exposure vaccination

4.5.1 History of vaccination

In the UK, pertussis-containing vaccines at the time of exposure was initially only recommended for unvaccinated or partially immunised contacts up to 10 years of age to provide long term protection. Since then, a number of studies have demonstrated the safety and immunogenicity of a combined tetanus/low dose diphtheria vaccine/low dose acellular pertussis (Tdap) vaccine in adolescents and adults (76 to 78). Three licensed low dose acellular pertussis containing vaccines (Repevax®, Adacel® Boostrix®-IPV) are suitable for boosting in adolescents and adults in the UK.

Although duration of immunity following initial acellular pertussis vaccination has not been clearly established, a review based on limited studies suggested duration of protection for 5 TO 6 years (79). Persistence of immunity for 6 to 9 years after a booster administered in the second year of life was reported for children receiving a 3-component acellular pertussis vaccine (80).

In October 2001, a booster dose of an acellular pertussis-containing vaccine was introduced into the UK routine schedule for children aged between 3 years 4 months and 5 years. Children born before November 1996 would have been eligible for only 3 primary doses of (whole cell) pertussis-containing vaccine during infancy. In these individuals in particular, protection is likely to have waned (81). Therefore, in the event of exposure, contacts over 10 years (many of whom would only have been eligible to receive a 3-dose primary course), whether they be unvaccinated, partially or fully immunised, are likely to benefit from a dose of pertussis-containing vaccine, especially given their role in transmission.

To determine the potential value of vaccination as part of an outbreak control strategy in adults, the immediate immune response to vaccination in adult healthcare workers at the time of exposure has been investigated (82). Of the 106 healthcare staff immunised during a 2006 US outbreak, Tdap antibody responses were noticeable at one week following vaccination with more than 50% of subjects showing a response to filamentous haemagglutinin, pertactin and fimbriae and 46% showing a booster response to pertussis toxoid (82). By 2 weeks between 88% and 94% showed a booster response, depending on the specific pertussis antigen. Vaccine effectiveness could not be determined in this study because there was no unvaccinated control population (83). However, the data suggest early Tdap vaccination may be valuable in preventing illness and transmission among adults in outbreak settings, reducing susceptibility of the population within 1 to 2 weeks.

One concern regarding the use of pertussis-containing vaccines in children over ten years is increased rates of severe local reactions, including Arthus-type reactions, if Tdap (Tetanus, diphtheria and pertussis) containing vaccine is administered too soon after a previous Td-IPV vaccine in older children and adults, either as part of the adolescent booster (which is offered to all 14 year olds in the UK), as a booster prior to travel or as part of the post exposure management for diphtheria or tetanus (84, 85). In pre-licensure clinical trials of Tdap in adolescents, those who had received doses of a diphtheria or tetanus toxoid-containing vaccine during the preceding 5 or 10 years were excluded (86). However, a Canadian study, which investigated the safety of administering a dose of Tdap at intervals less than 5 years after paediatric DTaP or Td concluded that Tdap can be safely administered at intervals of more than 18 months since a previous Td vaccine (87). Two smaller Canadian post-licensure safety studies in adolescents have also shown acceptable safety when Tdap is administered at intervals less than 5 years (88, 89). Based on these findings, Canada's National Advisory Committee on Immunization (NACI) concluded that there is no evidence of increased risk of severe adverse events for Canadian adolescents after receiving diphtheria and tetanus toxoid-containing vaccines at intervals of less than 5 years (89). In 2006, the US Advisory Committee on Immunization Practices (ACIP) recommended that adolescents who had received Td booster vaccine should receive Tdap for added protection, preferably with a five year interval to reduce

the risk of local and systemic reactions, although an interval of less than 5 years may be use (87).

Furthermore, the authors of a randomised, double-blind study in France, which assessed the safety of Tdap-IPV administered one month after vaccination with Td-IPV in 500 healthy adults, concluded that Tdap-IPV may be administered to adults as little as one month after Td-IPV without significantly increasing the frequency or severity of side-effects relative to considerably longer vaccination intervals (90).

4.5.2 Current post-exposure vaccination recommendations

Based on the currently available evidence, these guidelines recommend extending the offer of post-exposure vaccination with pertussis containing vaccine beyond unimmunised or partially immunised contacts below 10 years of age. In households where there is a clinically suspected or confirmed case of pertussis and a close contact in a priority group, pertussis containing vaccine should also be offered to all household contacts over 10 years of age, who have not received a dose of pertussis containing vaccine in the last five years and no Td-IPV vaccine in the preceding month.

The duration of immunity following immunisation with pertussis-containing vaccines is not fully established (80, 91) but the relatively high incidence of laboratory-confirmed pertussis in the 10-14 year age group during re-emergence of the disease in 2012 suggests that protection from the booster lasts less than 10 years (92). Therefore, the period for which previous doses of pertussis containing vaccine should be considered in assessment of prior protection is set at up to 5 years. No upper limit of age for adult vaccination is specified in the summary of product characteristics (SPC) for Repevax® or Boostrix®- IPV and ADACEL® (93 to 95).

4.5.3 Use of vaccination in pregnant women

In addition to the programme to vaccinate pregnant women in the UK, recommendations by the ACIP in the US advise that pregnant women receive a Tdap vaccine regardless of their previous vaccine history, in every pregnancy, ideally between 27 and 36 weeks (96). Ireland, Argentina, Israel and some parts of New Zealand and Australia also recommend the use of pertussis-containing vaccine during pregnancy (97 to 101).

Although pregnant women themselves are not thought to be at any greater risk of severe or complicated infection (56), the rationale for vaccination during pregnancy is to provide direct passive protection to vulnerable newborn infants through transplacental transfer of antibody. Studies of antibody response suggest that a maximum response to pertussis containing vaccines is not achieved until 14 days after vaccination, and as such, post-partum vaccination may not provide timely protection for newborn infants during the most vulnerable period (102).

All subclasses of IgG are transferred from mother to infant across the placenta, primarily during the third trimester of pregnancy (103). Data from the pre-vaccine era suggest that maternal

antibodies may provide at least short-term protection, for newborn infants, the proportion of deaths being lower in children less than one month of age when compared with those aged 1 to 3 months (104). Transplacental transfer of pertussis IgG antibody has been demonstrated with concentrations in the newborn (105, 106) or cord serum samples (107 to 109) reflecting those in the mother. Indeed, higher concentrations of pertussis antibodies have been demonstrated in cord blood for newborn infants of vaccinated when compared with unvaccinated mothers (35, 109).

These are said to have a half-life of approximately six weeks and so if boosted to sufficiently high levels are likely to provide time-limited, passive protection for newborn infants prior to administration of the first childhood pertussis-containing immunisation at age 8 weeks (105, 110). Evaluation of the maternal vaccination programme in England has demonstrated a more than 90% reduction in the risk of disease in infants up to three months of age when the mothers were vaccinated more than one week prior to delivery compared to infants of unvaccinated mothers, though the reduction between 2 to 3 months attributable to vaccination was unclear (111, 112). Subsequent analysis focusing on timing of vaccination identified high effectiveness against both infant hospitalisation (89%, 95% CI 86 to 91%) and infant death (97%, 81 to 100%) following extension of the offer of prenatal vaccination to women as early as week 16 of pregnancy (113).

In summary, the main rationale for offering post exposure vaccination to pregnant women is different to the main rationale for offering vaccination routinely to all pregnant women. In the post-exposure situation, the vaccine is given to reduce the risk of the infant (prior to their own routine pertussis immunisation) getting exposed to maternal pertussis infection, hence vaccination being given to those exposed late enough in pregnancy (over 32 weeks). In addition, if a woman has had confirmed or suspected whooping cough during pregnancy, she should still be offered the pertussis vaccine as not all women may make sufficiently high levels of antibodies following natural infection to ensure high levels can be passed across the placenta to the infant. As high levels of antibodies are made following vaccination, offering vaccine from 16 weeks of pregnancy should ensure that optimal antibody levels can be passed to her baby.

4.6 Risk of transmission in healthcare settings

Outbreaks of pertussis in healthcare settings and exclusion of affected staff can be disruptive and costly to manage (114). Several instances of pertussis transmission in healthcare settings have been reported in the literature and include transmission from HCW to HCW (114 to 117), HCW to patient (115, 118, 119) as well as patient to HCW (116, 120, 121) or a mixture of these (122, 123). However, the greatest risk of nosocomial transmission is likely to be from an HCW to a patient or to another member of staff.

Individuals with pertussis are most infectious in the initial catarrhal stage and during the first 3 weeks after the onset of cough (2). Pertussis is transmitted by infectious respiratory particles (IRPs) (124). Previous iterations of this guidance had highlighted research evidence

indicating that IRPs can be dispersed to a distance of 6 feet (1.9 metres) during coughing (125) but that *B. pertussis* DNA has been detected as far away as 4 metres (13 feet) from a patient's bedside for up to 4 days following initiation of therapy (126). Current WHO technical guidance states that larger IRPs will typically fall to surfaces within 1 to 2 metres of point of emission, but that distance travelled is dependent on a range of factors including IRP size, mode of expulsion (sneezing, coughing and shouting may all result in projection further than this distance) and other factors (127). The risk of transmission will therefore be dependent on the type of procedure undertaken and duration and proximity of exposure, with the risk being higher in settings involving close prolonged clinical contact, for example, intensive care and maternity settings.

The recommendations for chemoprophylaxis and post exposure vaccination require consideration of the nature of the healthcare setting where the exposure has occurred including level/proximity of contact, the vulnerability of those exposed and the effectiveness of available interventions.

Young unimmunised infants are at highest risk of severe complications, hospitalisation and death from pertussis. There is very little evidence supporting an increased risk of pertussis in other clinical risk groups such as individuals with underlying respiratory conditions, immunocompromised or pregnant women (38 to 40, 44 to 46, 128). The risk for pregnant women is in late pregnancy and relates to the potential transmission to the newborn. Pregnant women themselves do not appear to be at increased risk of severe pertussis compared with non-pregnant women. Although older children are at a lower risk of severe disease, they pose a risk of onward transmission. However, given the rapid turnover of patients in the paediatric setting, and the likelihood that the majority are likely to be completely or partially immunised, onward transmission within the healthcare setting is unlikely. Therefore, chemoprophylaxis for exposed older children in the healthcare setting is not routinely recommended.

The evidence of benefits of chemoprophylaxis is limited to close prolonged household type contact; evidence of effectiveness is limited outside of these settings (50). The primary accelerated infant vaccination schedule in the UK is highly effective in preventing severe complications in infants and young children (7). The current schedule (primary schedule plus preschool booster) is thought to provide protection in children until at least 10 years of age (7). Although the duration of protection from boosters administered in adolescence and adulthood has not been clearly established, post exposure vaccination has the potential to provide longer term protection against current and future exposures. The use of pertussis booster vaccination in a hospital outbreak in the USA demonstrated rapid antibody responses and the potential to reduce susceptibility of the population within 1 to 2 weeks (82).

In light of the above evidence, these guidelines restrict the use of wider chemoprophylaxis and vaccination to healthcare settings where the risks from pertussis transmission are highest – that is, settings involving infants and pregnant women. In all other healthcare settings, case management and provision of information and advice to contacts with significant exposure to seek health advice if they develop symptoms are recommended. Chemoprophylaxis and post

exposure vaccination is **not** recommended in healthcare settings where pregnant women or infants are not involved.

4.7 Risk of transmission in educational and childcare settings

4.7.1 Overview of evidence on transmission in these settings

Outbreaks of pertussis in educational settings have been reported in England and in the international literature although this evidence is piecemeal and comparison is complicated by cross-national variations in the models by which childcare and early years education are delivered (51, 129 to 134). Nevertheless, available evidence indicates potentially high secondary attack rates in these settings, including in nursery and pre-school settings more likely to cater to vulnerable infants (135).

Trends for outbreaks in educational settings in England in recent years are however indicative of an evolving risk profile over time. Prior to the COVID-19 pandemic, annual outbreak numbers in educational settings rose from 4 in 2014 to 24 in 2019. Despite the rapid and marked fall in pertussis cases following the introduction of measures to help control the SARS-CoV-2 pandemic, small numbers of outbreaks in educational settings continued to be reported in 2020 and 2021. During the 2023 to 2024 outbreak in England, the most common contexts for pertussis incidents were schools and nurseries.

In view of the sparse nature of literature on risks in educational settings, evidence in the following section is set out as a series of case studies of real-world outbreaks in England, and management approaches taken in each case. These underpin recommendations by setting type given in section 3.2.

4.7.2 Real-world case studies of educational setting outbreak management

A. Boarding school

Publication: Retrospective cohort study investigating extent of pertussis transmission during a boarding school outbreak, England, December 2017 to June 2018 (133).

Point of contact for further information: immunisation.lead@ukhsa.gov.uk

Setting

All-female boarding school in England with students aged 11 to 18 years.

Epidemiology

Two serologically confirmed cases between 21 March and 1 May 2018. Further investigation identified 2 further confirmed cases and 1 suspected case across year groups 9 to 13 and with onsets between 25 February and 16 April 2018. Investigations in the setting identified

widespread transmission with 48% of the 504 individuals tested having evidence of carriage or recent infection.

Control measures
Initial outbreak response – single dose of pertussis-containing vaccine recommended for all student boarders in years 9 to 13 who were housed separately from younger boarders. Vaccine was also offered to selected staff members (between 11 and 15 May 2018).

Active case-finding through a short questionnaire, throat swabbing, and oral fluid swabbing was undertaken before initial vaccination in collaboration with UKHSA Immunisation Division and the reference laboratory. This indicated extensive transmission and vaccination was extended to the younger school years.

Learning from this outbreak
There should be a low index of suspicion when multiple pertussis cases are notified in the same secondary school; symptoms are often mild in this age group, so the scale of the outbreak is likely to be larger than the number of notified cases. In semi-closed settings such as this boarding school (where most pupils were boarding) careful consideration should be made of the cohorts of students that appear unaffected but who have opportunities to mix with affected students.

B. Nursery setting
Publication: not published.

Point of contact for further information: immunisation.lead@ukhsa.gov.uk

Setting
Nursery setting with 3 rooms which included: 18 children in a room for 1 to 2 year olds; 41 children in a room for 2 to 3 year olds and 35 children in a room for 3 to 5 year olds.

Epidemiology
Two confirmed cases in the room for 1 to 2 year olds with onset between 23 July and 7 August 2020. It was also notable that several children in this room had a cough and runny noses. Some children were sent home as a precaution by the nursery with instructions to organise a coronavirus (COVID-19) test. All COVID-19 tests came back negative.

Control measures
A warn and inform letter was sent to parents of all children in the room for 1 to 2 year olds and staff. The letter was subsequently sent to parents of every child at the nursery highlighting signs and symptoms of pertussis to be aware of, the need to ensure children had received their routine childhood vaccinations and to advise that any pregnant contacts had also accessed the pertussis vaccination as per routine advice. The letter asked for children or staff not to attend the nursery if they were symptomatic and to seek medical advice.

The HPT sent a batch of nose and throat swabs to the nursery for parents and staff to pick up and swab anyone symptomatic. The used swabs were posted back to the Public Health Laboratory for whole viral respiratory panel testing. The HPT advised that symptomatic children and staff remain away from the nursery until they received a negative swab result or at least 48 hours of a course of antibiotics, if positive for pertussis.

Movement of children into older age group rooms was scheduled but this was postponed whilst the investigation was ongoing. Of 31 swabs processed by the lab for pertussis and COVID-19 none were positive for either but there was a single positive result for Bordetella parapertussis.

C. Primary school setting

Publication: Investigation of a pertussis outbreak and comparison of 2 acellular booster pertussis vaccines in a junior school in South East England, 2019 (132).

Point of contact for further information immunisation.lead@ukhsa.gov.uk

Setting

Local primary (infant and junior closely linked) school in England with 427 students aged 7 to 11 years.

Epidemiology

One serologically confirmed case of pertussis was notified in mid-March 2019. This case had symptom onset in February 2019. Six further (suspected or confirmed) cases were identified in the following days; one was the sibling of case 1 (who attended the linked infant school), the class teacher of case 1 and 4 other pupils in the same class. All of whom had seen the same GP.

Control measures

Following the first case and the head teacher reporting many cough absences at school, a letter was sent to all parents of pupils attending the junior school to raise awareness of the signs and symptoms of pertussis infection. This prompted further reports of students absent with cough illness and 4 additional students were subsequently notified as possible cases with onset dates from late January 2019. By the end of March 2019, 4 confirmed cases and 17 probable cases of pertussis in students who had presented to their GP had been identified.

An incident management team meeting was convened at the beginning of April 2019. All students in the junior school were offered a booster dose of pertussis-containing vaccine regardless of their vaccine status at the school on 1 and 2 May 2019.

As this was the first outbreak in a primary school setting that had been notified since the pre-school booster dose was introduced in 2001 enhanced case finding was undertaken. Parents of all students in the junior school were asked to complete a clinical questionnaire and for their consent for their child to have an oral fluid sample taken. A total of 134 of 381 (35.2%) students at the school were classified as pertussis cases during the outbreak (133 based on oral fluid

testing and one clinically diagnosed). Thirty-nine (29.1%) of the confirmed cases were asymptomatic and did not report any cough.

D. Secondary school setting

Publication: not published.

Point of contact for further information: immunisation.lead@ukhsa.gov.uk

Setting

Local secondary school.

Epidemiology

Three confirmed cases across 3 school year groups, with onset in December 2019 (year 7 pupil) and March 2020 (year 9 and 10 pupil). This was in the context of increased local pertussis activity, particularly in the under 16 year age group in this community

Control measures

The situation was discussed with the school, a warn and inform letter was disseminated to parents through the school in early March 2020. The school was advised to have a low threshold for further cases and to contact the local HPT if there were any further suspected cases. No further cases were reported to the HPT.

A GP letter was disseminated to inform local primary care services about the increased number of confirmed pertussis cases in the area and to stress the importance of:

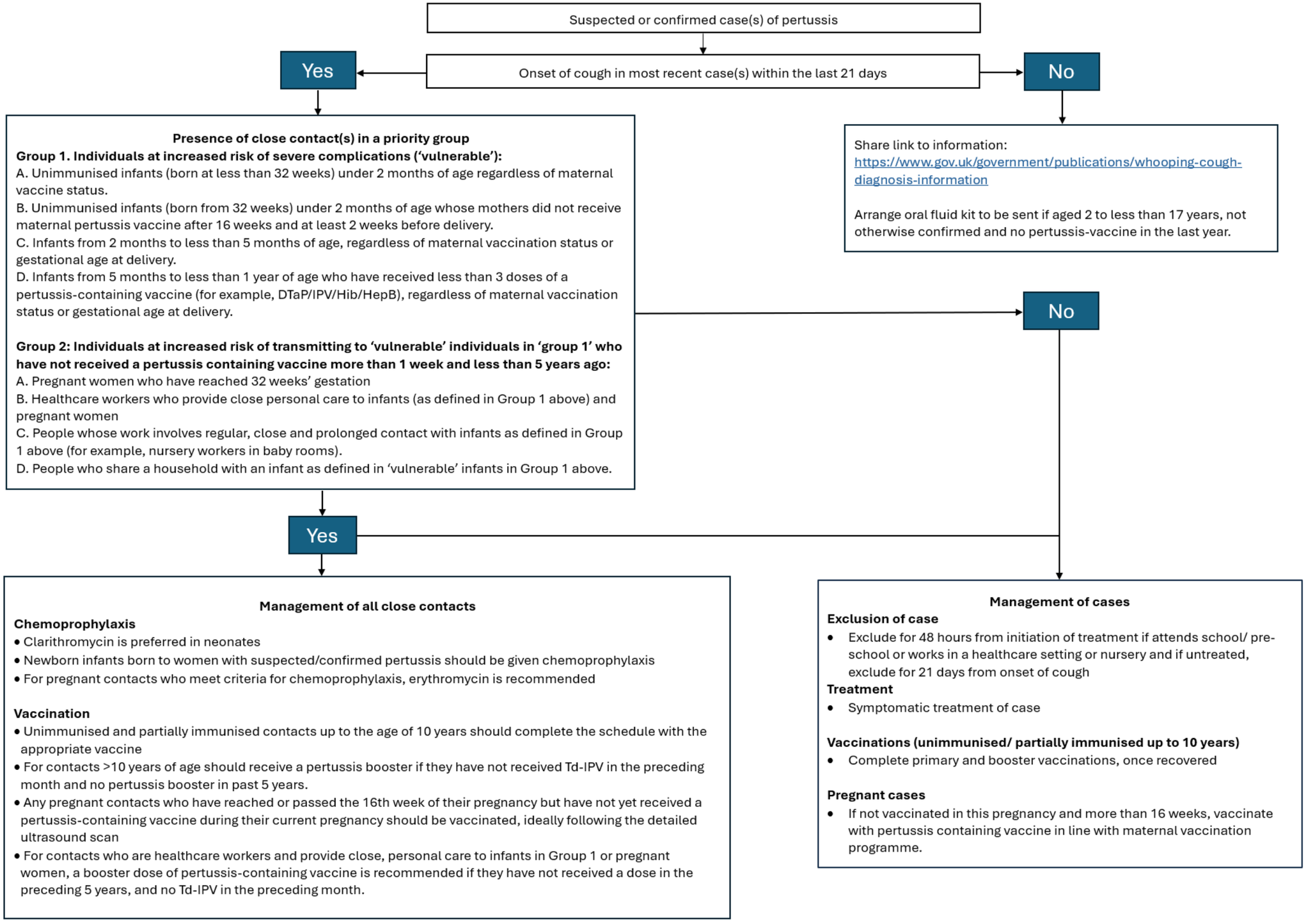
- ensuring that children and pregnant women were fully vaccinated
- prompt notification of suspected cases
- consideration of a diagnosis of pertussis in persons presenting with prolonged cough
- requesting for testing early enough so that effective public health action could be implemented, including highlighting the age group eligible for oral fluid testing

A letter for maternity units to encourage good uptake of the maternal pertussis programme and encouraging pregnant women with symptoms to avoid settings where they may be in contact with other people until 48 hours after starting antibiotic treatment was also shared.

5. Appendices

5.1 Flowchart summaries of case and contact management

Management of suspected or confirmed pertussis cases and their contacts



Text version of 'Management of suspected or confirmed pertussis cases and their contacts'

1. Identify cases
- Suspected or confirmed case(s) of pertussis are identified.

2. Assess timing of illness
- Determine whether the onset of cough in the most recent case occurred within the last 21 days.

3. If onset of cough was more than 21 days ago
- Share relevant information resources.
- Arrange oral fluid testing for children aged 2 to less than 17 years who are not otherwise confirmed and have not received pertussis vaccine in the last year.

4. If onset of cough was within 21 days
- Assess whether there are close contacts in **priority groups for public health action (Group 1 or Group 2)**.

5. If there are no close contacts in priority groups
- Manage the case as per standard guidance, including:
    - exclusion of the case
    - symptomatic treatment
    - vaccination where indicated

6. If there are close contacts in priority groups
- Initiate management of all close contacts.

Management of close contacts

Chemoprophylaxis
- Offer chemoprophylaxis where indicated.
- Clarithromycin is preferred in neonates.
- Newborn infants born to women with suspected or confirmed pertussis should receive chemoprophylaxis.
- For pregnant contacts who meet criteria, erythromycin is recommended.

Vaccination
- Unimmunised and partially immunised contacts up to 10 years of age should complete the routine schedule.
- Contacts aged over 10 years should receive a pertussis booster if no Td-IPV has been given in the preceding month and no pertussis-containing vaccine in the past 5 years.
- Pregnant contacts who have reached or passed the 16th week of their pregnancy but have not yet received pertussis vaccination in their current pregnancy should be offered vaccination, ideally following the detailed ultrasound scan.

- for contacts who are healthcare workers and provide close, personal care to infants in Group 1 or pregnant women, a booster dose of pertussis-containing vaccine is recommended if they have not received a dose in the preceding 5 years, and no Td-IPV in the preceding month.

Management of cases

Exclusion

- Exclude cases for 48 hours after initiation of appropriate antibiotic treatment.
- If untreated, exclude for 21 days from onset of cough.

Treatment

- Provide symptomatic management and antibiotic treatment where indicated.

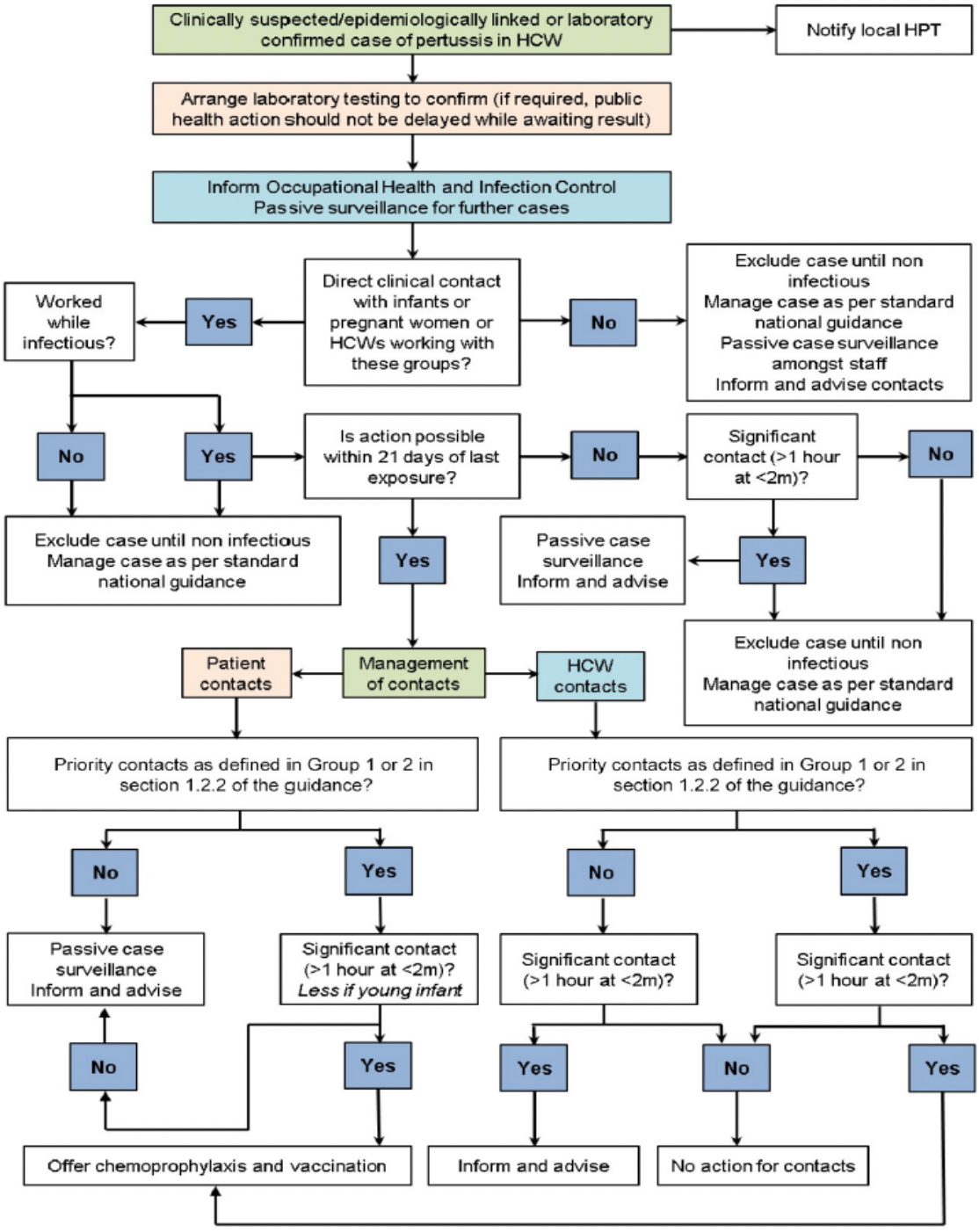
Vaccination

- Unimmunised or partially immunised individuals (up to 10 years) should complete primary and booster vaccinations after recovery.

Pregnant cases

- If not vaccinated in the current pregnancy and more than 16 weeks' gestation, offer pertussis-containing vaccine in line with the maternal vaccination programme.

Process for management of HCW index case



Text version of ‘Process for management of HCW index case’

1. Identify case
- A clinically suspected, epidemiologically linked or laboratory-confirmed case of pertussis is identified in a healthcare worker (HCW).
- Notify the local health protection team (HPT).

2. Initial actions
- Arrange laboratory testing if required (public health action should not be delayed while awaiting results).
- Inform occupational health and infection prevention and control teams.
- Initiate passive surveillance for further cases.

3. Assess risk of exposure
- Determine whether the HCW had direct clinical contact with:
    - infants
    - pregnant women
    - healthcare workers working with these groups

4. If no direct contact with these groups
- Exclude the case until non-infectious.
- Manage the case as per standard national guidance.
- Continue passive surveillance among staff.
- Inform and advise contacts.

5. If direct contact occurred
- Determine whether the HCW worked while infectious.

If the HCW did not work while infectious
- Exclude the case until non-infectious.
- Manage according to standard national guidance.

If the HCW worked while infectious
- Assess whether public health action is possible within 21 days of last exposure.

6. If action is not possible within 21 days
- Undertake passive case surveillance.
- Inform and advise contacts.
- If there was significant contact (>1 hour within <2 metres):
    - exclude the case until non-infectious
    - manage according to standard national guidance

7. If action is possible within 21 days
- Identify and classify contacts:

    - patient contacts
    - healthcare worker contacts
- Determine whether contacts fall into Group 1 or Group 2 priority groups.

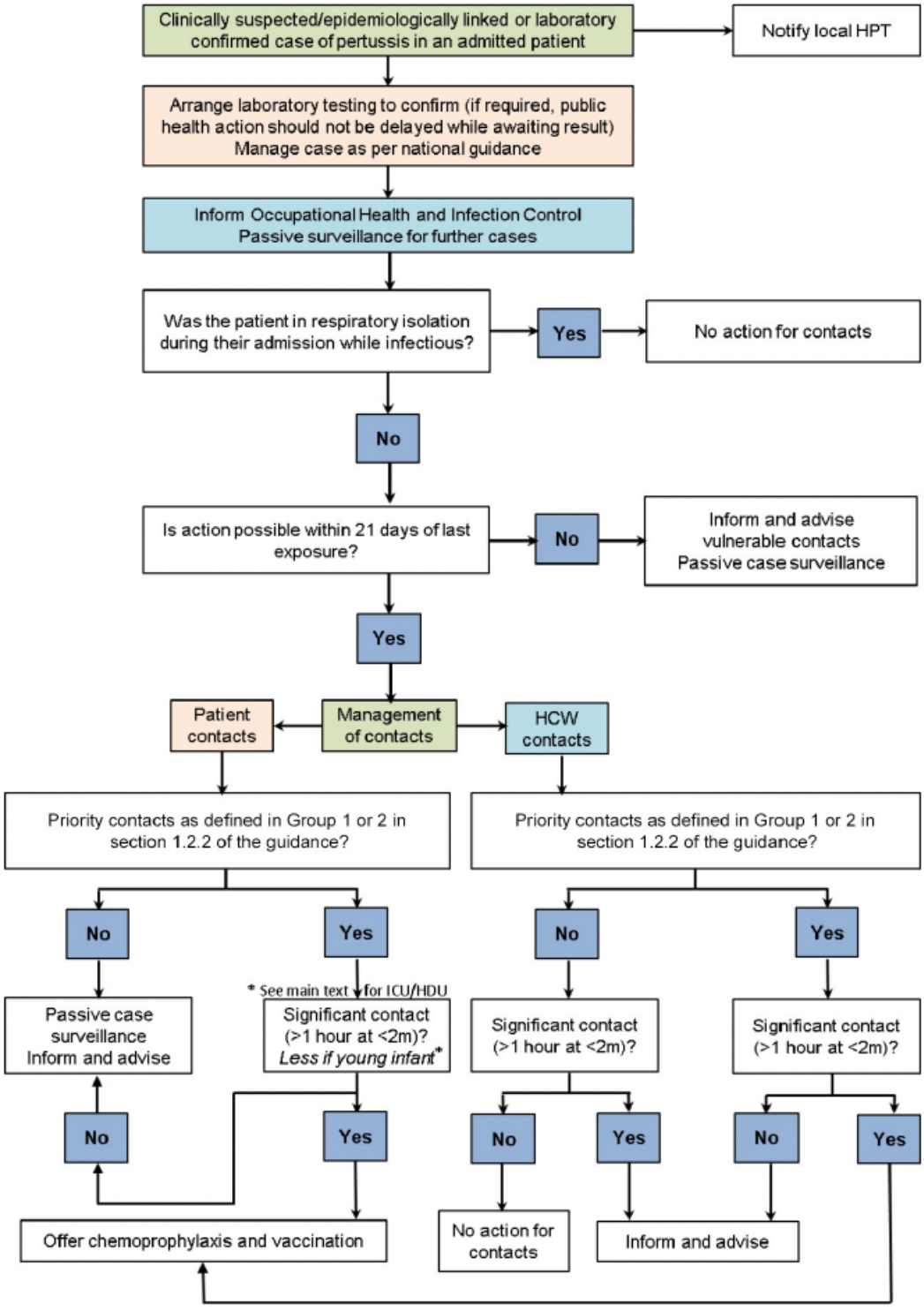
Management of patient contacts

- If contacts are **not in priority groups**:
    - undertake passive surveillance
    - inform and advise contacts
- If contacts **are in priority groups**:
    - assess for significant contact:
        - greater than 1 hour within less than 2 metres
        - shorter duration if involving a young infant
    - If significant contact occurred:
        - offer chemoprophylaxis and vaccination
    - If no significant contact:
        - undertake passive surveillance
        - inform and advise contacts

Management of healthcare worker contacts

- If contacts are **not in priority groups**:
    - assess for significant contact:
        - if YES: inform and advise
        - if NO: no action required
- If contacts **are in priority groups**:
    - assess for significant contact (>1 hour within <2 metres):
        - if YES: offer chemoprophylaxis and vaccination
        - if NO: no action required

Process for management of hospitalised index case



Text version of ‘Process for management of hospitalised index case’

1. Identify case

- A clinically suspected, epidemiologically linked or laboratory-confirmed case of pertussis is identified in an admitted patient.
- Notify the local health protection team (HPT).

2. Initial actions

- Arrange laboratory testing if required (public health action should not be delayed while awaiting results).
- Manage the case in accordance with national guidance.
- Inform occupational health and infection prevention and control teams.
- Initiate passive surveillance for further cases.

3. Assess infection control during admission

- Determine whether the patient was in respiratory isolation while infectious.

4. If the patient was in respiratory isolation

- No public health action is required for contacts.

5. If the patient was not in respiratory isolation

- Assess whether public health action is possible within 21 days of last exposure.

6. If action is not possible within 21 days

- Inform and advise vulnerable contacts.
- Undertake passive case surveillance.

7. If action is possible within 21 days

- Identify and classify contacts:
    - patient contacts
    - healthcare worker (HCW) contacts
- Determine whether contacts fall into **Group 1 or Group 2 priority groups** (as defined in the guidance).

Management of patient contacts

- If contacts are **not in priority groups**:
    - undertake passive case surveillance
    - inform and advise contacts
- If contacts are **in priority groups**:
    - assess for significant contact:
        - greater than 1 hour within less than 2 metres
        - shorter duration for young infants
    - If significant contact occurred:
        - offer chemoprophylaxis and vaccination
    - If no significant contact:

        - undertake passive surveillance
        - inform and advise contacts

Management of healthcare worker contacts

- If contacts are **not in priority groups**:
    - assess for significant contact (>1 hour within <2 metres)
        - if YES: inform and advise
        - if NO: no action required
- If contacts are **in priority groups**:
    - assess for significant contact (>1 hour within <2 metres)
        - if YES: offer chemoprophylaxis and vaccination
        - if NO: no action required

5.2 Testing for pertussis in primary care

Summary of pertussis testing for primary care

5.3 Pertussis oral fluid laboratory test request form

Pertussis oral fluid laboratory request form and instructions

5.4 Enhanced pertussis disease surveillance form

Pertussis: enhanced surveillance form

5.5 Severe or fatal pertussis disease surveillance form for infants and children

UKHSA severe or fatal pertussis disease surveillance form for infants and children

5.6 Reporting form for pertussis outbreaks in healthcare settings

Pertussis outbreaks in healthcare settings surveillance form

5.7 Template letters for use in childcare, educational and healthcare settings

Template letters for use in childcare, educational and healthcare settings can be found at Pertussis: guidelines for public health management

5.8 Antibiotic treatment and chemoprophylaxis recommendations [note 1]

Age group	Clarithromycin	Azithromycin	Erythromycin	Co-trimoxazole [note 3]
Neonates (<1 month) [note 4]	Preferred in neonates 7.5mg/kg twice a day for 7 days	10mg/kg once a day for 3 days	10 to 15mg/kg every 6 hours for 7 days	Not licensed for infants below 6 weeks
Infants (1 month to 12 months) **and** **children (12 months and older)**	**1 month to 11 years** **Under 8kgs** 7.5mg/kg twice a day for 7 days **8 to 11kg** 62.5mg twice a day for 7 days **12 to 19kg** 125mg twice a day for 7 days **20 to 29kg** 187.5mg twice a day for 7 days **30 to 40kg** 250mg twice a day for 7 days **12 to 17 years** 500mg twice a day for 7 days	**1 to 6 months** 10mg/kg once a day for 3 days **> 6 months** 10mg/kg (max 500mg) once a day for 3 days	**1 to 23 months** 125mg every 6 hours for 7 days [note 2] **2 to 7 years** 250mg every 6 hours for 7 days [note 2] **8 to 17 years** 250 to 500mg every 6 hours for 7 days [note 2]	**6 weeks to 5 months** 120mg twice a day for 7 days **6 months to 5 years** 240mg twice a day for 7 days **6 to 11 years** 480mg twice a day for 7 days **12 to 17 years** 960mg twice a day for 7 days
Adults	500mg twice a day for 7 days	500mg once a day for 3 days	500mg every 6 hours for 7 days [note 2]	960mg twice a day for 7 days
Pregnant women [note 5]	Third line – dosing as for adults above	Second line – dosing as for adults above	Preferred antibiotic – dosing as for adults above	**Should not be used in pregnancy, particularly in the first trimester, unless no other antibiotic option available**

Note 1: For all antibiotic prescribing recommendations given above, please consult the BNF or the BNF for children for cautions, interactions and side-effects prior to prescribing.
Note 2: Doses can be doubled in severe infections.
Note 3: Consider if macrolides contra-indicated or not tolerated.
Note 4: Please note that macrolides should be used with caution in neonates. An association between erythromycin and azithromycin use and hypertrophic pyloric stenosis in infants has been reported, but it is judged that the risk of severe outcomes from pertussis in this age group outweigh the risk of developing this complication.
Note 5: For pregnant contacts, a risk assessment would need to be done to looks at the risk and benefits of antibiotic therapy/prophylaxis. The aim of treating or prophylaxing women in pregnancy is to prevent transmission to the newborn infant and should be considered in those who have not either received a pertussis-containing vaccine within the past 5 years or received a pertussis-containing vaccine within the previous week. Where possible, pregnant women should begin treatment at least 3 days prior to delivery. Macrolide preferences outlined above are based on experience of use in pregnancy – for more information about macrolide prescribing in pregnancy refer to the UK Teratology Information Service website.

References

1. Dodhia H, Crowcroft NS, Bramley JC, Miller E. 'UK guidelines for use of erythromycin chemoprophylaxis in persons exposed to pertussis' Journal of Public Health Medicine 2002: volume 24, issue 3, pages 200 to 206
2. Tiwari T, Murphy TV, Moran J. 'Recommended antimicrobial agents for the treatment and postexposure prophylaxis of pertussis' MMWR 2005: volume 54, issues RR-14, pages 1 to 16
3. Cherry JD, Tan T, Wirsing von König C-H, Forsyth KD, Thisyakorn U, Greenberg D and others. 'Clinical definitions of pertussis: Summary of a Global Pertussis Initiative roundtable meeting, February 2011' Clinical Infectious Diseases 2012: volume 54, issue 12, pages 1,756 to 1,764
4. UKHSA. Pertussis: the Green Book, chapter 24. Immunisation against infectious disease (2024)
5. UKHSA. Pertussis (whooping cough) vaccination programme for pregnant women: information for healthcare practitioners (2024)
6. UKHSA. Laboratory-confirmed cases of pertussis in England: annual report for 2023 (2024)
7. Campbell H, Amirthalingam G, Andrews N, Fry NK, George RC, Harrison TG, and others. 'Accelerating control of pertussis in England and Wales' Emerging infectious diseases 2012: volume 18, issue 1, page 38
8. Choi YH, Campbell H, Amirthalingam G, van Hoek AJ, Miller E. 'Investigating the pertussis resurgence in England and Wales, and options for future control' BMC Medicine 2016: volume 14, issue 1, page 121
9. UKHSA. Laboratory-confirmed cases of pertussis in England: annual report for 2024. 2025.
10. Tessier E, Campbell H, Ribeiro S, Rai Y, Burton S, Roy P, and others. 'Impact of the COVID-19 pandemic on Bordetella pertussis infections in England' BMC Public Health 2022: volume 22, issue 1, page 405
11. Celentano LP, Massari M, Paramatti D, Salmaso S, Tozzi AE. 'Resurgence of pertussis in Europe' The Pediatric Infectious Disease Journal 2005: volume 24, issue 9, pages 761 to 765
12. Schwartz KL, Kwong JC, Deeks SL, Campitelli MA, Jamieson FB, Marchand-Austin A, and others. 'Effectiveness of pertussis vaccination and duration of immunity' Cmaj 2016: volume 188, issue 16, pages E399 to E406
13. WHO. 'Pertussis vaccines: WHO position paper, August 2015--Recommendations' Vaccine 2016: volume 34, issue 12, pages 1,423 to 1,425
14. ECDC. Pertussis Annual Epidemiological Report for 2017 (2017)
15. UKHSA. Pertussis immunisation in pregnancy: vaccine coverage (England) (2024)
16. UKHSA. Cover of vaccination evaluated rapidly programme (2025)
17. UKHSA. Guidance - Notifiable diseases and how to report them (2024)
18. UKHSA. Notifiable diseases and how to report them. London: UKHSA; 2025.

19. Paisley RD, Blaylock J, Hartzell JD. 'Whooping cough in adults: an update on a reemerging infection' The American Journal Of Medicine 2012: volume 125, issue 2, pages 141 to 143
20. Sotir MJ, Cappozzo DL, Warshauer DM, Schmidt CE, Monson TA, Berg JL, and others. 'Evaluation of polymerase chain reaction and culture for diagnosis of pertussis in the control of a county-wide outbreak focused among adolescents and adults' Clinical Infectious Diseases 2007: volume 44, issue 9, pages 1,216 to 1,219
21. Wirsing von König C-H. Pertussis diagnostics: overview and impact of immunization Expert Review of Vaccines 2014: volume 13, issue 10, pages 1,167 to 1,174
22. Bamberger ES, Srugo I. 'What is new in pertussis?' European Journal of Pediatrics 2008: volume 167, pages 133 to 139
23. Fry NK, Duncan J, Wagner K, Tzivra O, Doshi N, Litt DJ, and others. 'Role of PCR in the diagnosis of pertussis infection in infants: 5 years' experience of provision of a same-day real-time PCR service in England and Wales from 2002 to 2007' Journal of Medical Microbiology 2009: volume 58, issue 8, pages 1,023 to 1,029
24. Loeffelholz M. 'Towards improved accuracy of Bordetella pertussis nucleic acid amplification tests' Journal of Clinical Microbiology 2012: volume 50, issue 7, pages 2,186 to 2,190
25. ECDC. 'Laboratory diagnosis and molecular surveillance of Bordetella pertussis' (2022)
26. Xing D, Wirsing von König CH, Newland P, Riffelmann M, Meade BD, Corbel M, and others. 'Characterization of reference materials for human antiserum to pertussis antigens by an international collaborative study' Clinical and Vaccine Immunology 2009: volume 16, issue 3, pages 303 to 311
27. Fry NK, Litt DJ, Duncan J, Vaghji L, Warrener L, Samuel D, and others. 'Modelling anti-pertussis toxin IgG antibody decay following primary and preschool vaccination with an acellular pertussis vaccine in UK subjects using a modified oral fluid assay' Journal of Medical Microbiology 2013: volume 62, part 9, pages 1,281 to 1,289
28. Litt DJ, Samuel D, Duncan J, Harnden A, George RC, Harrison TG. 'Detection of anti-pertussis toxin IgG in oral fluids for use in diagnosis and surveillance of Bordetella pertussis infection in children and young adults' Journal of Medical Microbiology 2006: volume 55, part 9, pages 1,223 to 1,228
29. Campbell H, Amirthalingam G, Fry NK, Litt D, Harrison TG, Wagner K, and others. 'Oral fluid testing for pertussis, England and wales, June 2007 to August 2009' Emerging Infectious Diseases 2014: volume 20, issue 6, pages 968 to 975
30. Jenkinson D. 'Natural course of 500 consecutive cases of whooping cough: a general practice population study' BMJ 1995: volume 310, issue 6,975, pages 299 to 302
31. de Greeff SC, Mooi FR, Westerhof A, Verbakel J, Peeters MF, Heuvelman C, and others. 'Pertussis disease burden in the household: how to protect young infants' Clinical Infectious Diseases 2010: volume 50, issue 10, pages 1,339 to 1,345
32. Cortese MM, Baughman AL, Brown K, Srivastava P. 'A "new age" in pertussis prevention: new opportunities through adult vaccination' American Journal of Preventive Medicine 2007: volume 32, issue 3, pages 177 to 185, article e1
33. Gidengil CA, Sandora TJ, Lee GM. 'Tetanus–diphtheria–acellular pertussis vaccination of adults in the USA' Expert Review of Vaccines 2008: volume 7, issue 5, pages 621 to 634

34. Milord F. ‘Resurgence of pertussis in Montérégie, Quebec--1990-1994’ Canada Communicable Disease Report= Releve des Maladies Transmissibles au Canada 1995 : volume 21, issue 5, pages 40 to 44
35. Gall SA, Myers J, Pichichero M. ‘Maternal immunization with tetanus–diphtheria–pertussis vaccine: effect on maternal and neonatal serum antibody levels’ American Journal of Obstetrics and Gynecology 2011 : volume 204, issue 4, 334, e1 to e5
36. Schellekens J, von König C-HW, Gardner P. Pertussis sources of infection and routes of transmission in the vaccination era’ The Pediatric Infectious Disease Journal 2005: volume 24, issue 5, pages S19 to S24
37. de Martino M, Podda A, Galli L, Sinangil F, Mannelli F, Rossi ME, and others. ‘Acellular pertussis vaccine in children with perinatal human immunodeficiency virus-type 1 infection’ Vaccine 1997: volume 15, issue 11, pages 1,235 to 1,238
38. Janda WM, Santos E, Stevens J, Celig D, Terrile L, Schreckenberger PC. ‘Unexpected isolation of Bordetella pertussis from a blood culture’ Journal of Clinical Microbiology 1994: volume 32, issue 11, pages 2,851 to 2,853
39. Trøseid M, Jonassen TØ, Steinbakk M. ‘Isolation of Bordetella pertussis in blood culture from a patient with multiple myeloma’ Journal of Infection 2006: volume 52, issue 1, pages e11 to e13
40. Control CfD, Prevention. ‘Fatal case of unsuspected pertussis diagnosed from a blood culture--Minnesota, 2003’ Morbidity and mortality weekly report 2004: volume 53, issue 6, pages 131 to 132
41. Doebbeling BN, Feilmeier ML, Herwaldt LA. ‘Pertussis in an adult man infected with the human immunodeficiency virus’ Journal of Infectious Diseases 1990: volume 161, issue 6, pages 1,296 to 1,298
42. Colebunders R, Vael C, Blot K, Van Meerbeeck J, Van den Ende J, Ieven M. ‘Bordetella pertussis as a cause of chronic respiratory infection in an AIDS patient’ European Journal of Clinical Microbiology and Infectious Diseases 1994: volume 13, pages 313 to 315
43. Adamson PC, Wu TC, Meade BD, Rubin M, Manclark CR, Pizzo PA. ‘Pertussis in a previously immunized child with human immunodeficiency virus infection’ 1989
44. De Serres G, Shadmani R, Duval B, Boulianne N, Déry P, Fradet MD, and others. ‘Morbidity of pertussis in adolescents and adults’ The Journal of Infectious Diseases 2000: volume 182, issue 1, pages 174 to 179
45. Harju TH, Leinonen M, Nokso-Koivisto J, Korhonen T, Räty R, He Q, and others. ‘Pathogenic bacteria and viruses in induced sputum or pharyngeal secretions of adults with stable asthma’ Thorax 2006: volume 61, issue 7, pages 579 to 584
46. Bonhoeffer J, Bär G, Riffelmann M, Soler M, Heininger U. ‘The role of Bordetella infections in patients with acute exacerbation of chronic bronchitis’ Infection 2005: volume 33, pages 13 to 17
47. Pichichero ME, Hoeger WJ, Casey JR. ‘Azithromycin for the treatment of pertussis’ The Pediatric Infectious Disease Journal 2003: volume 22, issue 9, pages 847 to 849
48. de Graaf H, Ibrahim M, Hill AR, Gbesemete D, Vaughan AT, Gorringe A, and others. ‘Controlled human infection with Bordetella pertussis induces asymptomatic, immunizing colonization’ Clinical Infectious Diseases 2020: volume 71. Issue 2, pages 403 to 411

49. Gbesemete D, Ramasamy MN, Ibrahim M, Hill AR, Raud L, Ferreira DM, and others. 'Efficacy, immunogenicity, and safety of the live attenuated nasal pertussis vaccine, BPZE1, in the UK: a randomised, placebo-controlled, phase 2b trial using a controlled human infection model with virulent Bordetella pertussis' The Lancet Microbe 2025: 101211
50. Dodhia H, Miller E. 'Review of the evidence for the use of erythromycin in the management of persons exposed to pertussis' Epidemiology and Infection 1998: volume 120, issue 2, pages 143 to 149
51. Khetsuriani N, Bisgard K, Prevots DR, Brennan M, Wharton M, Pandya S, and others. 'Pertussis outbreak in an elementary school with high vaccination coverage' The Pediatric Infectious Disease Journal 2001: volume 20, issue 12, pages 1,108 to 1,112
52. Terry JB, Flatley CJ, van den Berg DJ, Morgan GG, Trent M, Turahui JA, and others. 'A field study of household attack rates and the effectiveness of macrolide antibiotics in reducing household transmission of pertussis' Communicable Diseases Intelligence Quarterly Report 2015: volume 39, issue 1, pages E27 to E33
53. König CWv, Postels-Multani S, Bogaerts H, Bock H, Laukamp S, Kiederle S, and others. 'Factors influencing the spread of pertussis in households' European Journal of Pediatrics 1998: volume 157, pages 391 to 394
54. Halperin SA, Bortolussi R, Langley JM, Miller B, Eastwood BJ. 'Seven days of erythromycin estolate is as effective as fourteen days for the treatment of Bordetella pertussis infections'. Pediatrics 1997: volume 100, issue 1, pages 65 to 71
55. Halperin SA, Bortolussi R, Langley JM, Eastwood BJ, De Serres G. 'A randomized, placebo-controlled trial of erythromycin estolate chemoprophylaxis for household contacts of children with culture-positive Bordetella pertussis infection' Pediatrics 1999: volume 104, issue 4, pages e42 to e46
56. Kimberlin DW, Brady MT, Jackson MA, Long SS. 'Red book : 2015 report of the Committee on Infectious Diseases. 30th edition' (2015)
57. Altunaiji SM, Kukuruzovic RH, Curtis NC, Massie J. 'Cochrane Review: Antibiotics for whooping cough (pertussis)' Evidence-Based Child Health: A Cochrane Review Journal 2012: volume 7, issue 3, pages 893 to 956
58. Lebel MH, Mehra S. 'Efficacy and safety of clarithromycin versus erythromycin for the treatment of pertussis: a prospective, randomized, single blind trial' The Pediatric Infectious Disease Journal 2001: volume 20, issue 12., pages 1,149 to 1,154
59. Langley JM, Halperin SA, Boucher FD, Smith B, Canada PICNoIi. 'Azithromycin is as effective as and better tolerated than erythromycin estolate for the treatment of pertussis' Pediatrics 2004: volume 114, issue 1, pages e96 to e101
60. Giugliani C, Vidal-Trecan G, Traore S, Blanchard H, Spiridon G, Rollot F, and others. 'Feasibility of azithromycin prophylaxis during a pertussis outbreak among healthcare workers in a university hospital in Paris' Infection Control and Hospital Epidemiology 2006: volume 27, issue 6, pages 626 to 629
61. Guillot S, Descours G, Gillet Y, Etienne J, Floret D, Guiso N. 'Macrolide-resistant Bordetella pertussis infection in newborn girl, France' Emerging Infectious Diseases 2012: volume 18, issue 6, page 966

62. Fu P, Zhou J, Yang C, Nijiati Y, Zhou L, Yan G, and others. 'Molecular Evolution and Increasing Macrolide Resistance of Bordetella pertussis, Shanghai, China, 2016-2022' Emerging Infectious Disease 2023: volume 30, issue 1, pages 29 to 38
63. Ivaska L, Barkoff AM, Mertsola J, He Q. 'Macrolide Resistance in Bordetella pertussis: Current Situation and Future Challenges' Antibiotics (Basel) 2022: volume 11, issue 11
64. Miettinen M, Barkoff A-M, Nyqvist A, Savolainen-Kopra C, Antikainen J, Mertsola J, and others. 'Macrolide-resistant Bordetella pertussis strain identified during an ongoing epidemic, Finland, January to October 2024' Eurosurveillance 2024: volume 29, issue 49, page 2400765
65. Rodrigues C, Bouchez V, Soares A, Trombert-Paolantoni S, Aït El Belghiti F, Cohen JF, and others. 'Resurgence of Bordetella pertussis, including one macrolide-resistant isolate, France, 2024' Euro Surveillance 2024: volume 29, issue 31
66. Fry N, Duncan J, Vaghji L, George R, Harrison T. 'Antimicrobial susceptibility testing of historical and recent clinical isolates of Bordetella pertussis in the United Kingdom using the Etest method' European Journal Of Clinical Microbiology and Infectious Diseases 2010: volume 29, pages 1,183 to 1,185
67. Hoppe J, Halm U, Hagedorn H-J, Kraminer-Hagedorn A. 'Comparison of erythromycin ethylsuccinate and co-trimoxazole for treatment of pertussis' Infection 1989: 17, issue 4, pages 227 to 231
68. Henry RL, Dorman DC, Skinner JA, Mellis CM. 'Antimicrobial therapy in whooping cough' Medical Journal of Australia 1981: volume 2, 1 pages 27 to 28
69. Ribeiro C. 'Prophylactic erythromycin for whooping-cough contacts' The Lancet 1981: volume 317, issue 8,226, page 951
70. Alvarez J, Godoy P, Plans-Rubio P, Camps N, Carol M, Carmona G, and others. 'Azithromycin to prevent pertussis in household contacts, Catalonia and Navarre, Spain, 2012–2013' Emerging Infectious Diseases 2020: volume 26, issue 11, page 2,678
71. Excellence NIfHaC. British National Formulary (BNF) NICE (2025)
72. Louik C, Werler MM, Mitchell AA. 'Erythromycin use during pregnancy in relation to pyloric stenosis' American Journal of Obstetrics and Gynecology 2002: volume 186, issue 2, pages 288 to 290
73. Cooper WO, Ray WA, Griffin MR. 'Prenatal prescription of macrolide antibiotics and infantile hypertrophic pyloric stenosis' Obstetrics and Gynecology 2002: volume 100, issue 1, pages 101 to 106
74. Mahon BE, Rosenman MB, Kleiman MB. 'Maternal and infant use of erythromycin and other macrolide antibiotics as risk factors for infantile hypertrophic pyloric stenosis' The Journal of Pediatrics 2001: volume 139, issue 3, pages 380 to 384
75. UKHSA. Pertussis immunisation in pregnancy: vaccine coverage (England) (2025)
76. Van der Wielen M, Van Damme P, Joossens E, François G, Meurice F, Ramalho A. 'A randomised controlled trial with a diphtheria-tetanus-acellular pertussis (dTpa) vaccine in adults' Vaccine 2000: volume 18, issue 20, pages 2,075 to 2,082
77. Halperin SA, Smith B, Russell M, Scheifele D, Mills E, Hasselback P, and others. 'Adult formulation of a five component acellular pertussis vaccine combined with diphtheria and tetanus toxoids and inactivated poliovirus vaccine is safe and immunogenic in

adolescents and adults' Pediatric Infectious Disease Journal 2000: volume 19, issue 4, pages 276 to 283

78. Southern J, Andrews N, Burrage M, Miller E. 'Immunogenicity and reactogenicity of combined acellular pertussis/tetanus/low dose diphtheria vaccines given as a booster to UK teenagers' Vaccine 2005: volume 23, issue 29, pages 3,829 to 3,835
79. Wendelboe AM, Van Rie A, Salmaso S, Englund JA. 'Duration of immunity against pertussis after natural infection or vaccination' Pediatric Infectious Disease Journal 2005: volume 24, 5 supplement, pages S58 to S61
80. Guiso N, Njamkepo E, Le Sage FV, Zepp F, Meyer C, Abitbol V, and others. 'Long-term humoral and cell-mediated immunity after acellular pertussis vaccination compares favourably with whole-cell vaccines 6 years after booster vaccination in the second year of life' Vaccine 2007: volume 25, issue 8, pages 1,390 to 1,397
81. Van Buynder PG, Owen D, Vurdien JE, Andrews NJ, Matthews RC, Miller E. 'Bordetella pertussis surveillance in England and Wales: 1995-7' Epidemiology and Infection 1999: volume 123, issue 3, pages 403 to 411
82. Kirkland KB, Talbot EA, Decker MD, Edwards KM. 'Kinetics of pertussis immune responses to tetanus-diphtheria-acellular pertussis vaccine in health care personnel: implications for outbreak control' Clinical Infectious Diseases 2009: volume 49, issue 4, pages 584 to 587
83. Birkebaek NH. 'Bordetella pertussis booster vaccination for health care personnel immediately following a pertussis outbreak in a hospital?' Clinical Infectious Diseases 2009: volume 49, issue 4, pages 588 to 590
84. Galazka AM, Robertson SE. 'Immunization against diphtheria with special emphasis on immunization of adults' Vaccine 1996: volume 14, issue 9, pages 845 to 857
85. Ramsay M, Joce R, Whalley J. 'Adverse events after school leavers received combined tetanus and low dose diphtheria vaccine' Communicable Disease Report CDR Review 1997: volume 7, issue 5, pages R65 to R67
86. Broder KR, Cortese MM, Iskander JK, Kretsinger K, Slade BA, Brown KH, and others. 'Preventing tetanus, diphtheria, and pertussis among adolescents: ACIP recommendations (2006)
87. Halperin SA, Sweet L, Baxendale D, Neatby A, Rykers P, Smith B, and others. 'How soon after a prior tetanus-diphtheria vaccination can one give adult formulation tetanus-diphtheria-acellular pertussis vaccine?' Pediatric Infectious Disease Journal 2006: volume 25, issue 3, pages 195 to 200
88. David ST, Hemsley C, Pasquali PE, Larke B, Buxton JA, Lior LY. 'Enhanced surveillance for vaccine-associated adverse events: dTap catch-up of high school students in Yukon' Canada Communicable Disease Report 2005: volume 31, issue 11, pages 117 to 126
89. National Advisory Committee on I. 'Interval between administration of vaccines against diphtheria, tetanus and pertussis' (2015)
90. Beytout J, Launay O, Guiso N, Fiquet A, Baudin M, Richard P, and others. 'Safety of Tdap-IPV given one month after Td-IPV booster in healthy young adults: a placebo-controlled trial' Human Vaccines 2009: volume 5, issue 5, pages 315 to 321

91. Wendelboe AM, Van Rie A, Salmaso S, Englund JA. 'Duration of immunity against pertussis after natural infection or vaccination' The Pediatric Infectious Disease Journal 2005: volume 24, issue 5, pages S58 to S61
92. Public Health England. Laboratory confirmed cases of pertussis reported to the enhanced pertussis surveillance programme in England: Q4/2013' (2013)
93. Compendium EM. REPEVAX 2025
94. Compendium EM. Boostrix-IPV suspension for injection in pre-filled syringe (2025)
95. Compendium EM. ADACEL suspension for injection in pre-filled syringe (2025)
96. Havers FP. 'Use of tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccines: updated recommendations of the Advisory Committee on Immunization Practices—United States, 2019' MMWR Morbidity and Mortality Weekly Report 2020: volume 69
97. Vizzotti C, Neyro S, Katz N, Juárez M, Carrega MP, Aquino A, and others. 'Maternal immunization in Argentina: a storyline from the prospective of a middle income country' Vaccine 2015: volume 33, issue 47, pages 6,413 to 6,419
98. Health Service Eire. Immunisation Guidelines for Ireland
99. Australia Government Department of Health. Whooping Cough (pertussis) - The Australia Immunisation Handbook (2016)
100. Ministry of Health I. Whooping Cough Vaccination in Pregnant Women
101. Ministry of Health of New Zealand. Immunisation for pregnant women
102. Halperin B, Morris A, Mackinnon-Cameron D, Mutch J, Langley J, McNeil S, and others. 'Kinetics of the antibody response to tetanus-diphtheria-acellular pertussis vaccine in women of childbearing age and postpartum women' Clinical Infectious Diseases 2011: volume 53, issue 9, pages 885 to 892
103. Van Rie A, Wendelboe AM, Englund JA. 'Role of maternal pertussis antibodies in infants' The Pediatric Infectious Disease Journal 2005: volume 24, issue 5, pages S62 to S65
104. SAKO W, Treuting W, WITT DB, NICHAMIN SJ. 'Early immunization against pertussis with alum precipitated vaccine' Journal of the American Medical Association 1945: volume 127, issue 7, pages 379 to 384
105. Van Savage J, Decker MD, Edwards KM, Sell SH, Karzon DT. 'Natural history of pertussis antibody in the infant and effect on vaccine response' Journal of Infectious Diseases 1990: volume 161, issue 3, pages 487 to 492
106. Healy CM, Munoz FM, Rench MA, Halasa N, Edwards KM, Baker CJ. 'Prevalence of pertussis antibodies in maternal delivery, cord, and infant serum' The Journal of Infectious Diseases 2004: volume 190, issue 2, pages 335 to 340
107. Healy CM, Rench MA, Edwards KM, Baker CJ. 'Pertussis serostatus among neonates born to Hispanic women' Clinical Infectious Diseases 2006: volume 42, issue 10, pages 1,439 to 1,442
108. Gonik B, Puder KS, Gonik N, Kruger M. 'Seroprevalence of Bordetella pertussis antibodies in mothers and their newborn infants' Infectious Diseases in Obstetrics and Gynecology 2005: volume 13, issue 2, pages 59 to 61
109. Leuridan E, Hens N, Peeters N, de Witte L, Van der Meeren O, Van Damme P. 'Effect of a prepregnancy pertussis booster dose on maternal antibody titers in young infants' The Pediatric Infectious Disease Journal 2011: volume 30, issue 7, pages 608 to 610

110. Healy CM, Baker CJ. 'Prospects for prevention of childhood infections by maternal immunization' Current Opinion in Infectious Diseases 2006: volume 19, issue 3, pages 271 to 276
111. Amirthalingam G, Andrews N, Campbell H, Ribeiro S, Kara E, Donegan K, and others. 'Effectiveness of maternal pertussis vaccination in England: an observational study' The Lancet 2014: volume 384, issue 9,953, pages 1,521 to 1,528
112. Dabrera G, Amirthalingam G, Andrews N, Campbell H, Ribeiro S, Kara E, and others. 'A case-control study to estimate the effectiveness of maternal pertussis vaccination in protecting newborn infants in England and Wales, 2012–2013' Clinical Infectious Diseases 2015: volume 60, issue 3, pages 333 to 337
113. Amirthalingam G, Campbell H, Ribeiro S, Stowe J, Tessier E, Litt D, and others. 'Optimization of Timing of Maternal Pertussis Immunization From 6 Years of Postimplementation Surveillance Data in England' Clinical Infectious Diseases 2023: volume 76, issue 3, pages e1129 to e1139
114. Leekha S, Thompson RL, Sampathkumar P. 'Epidemiology and control of pertussis outbreaks in a tertiary care center and the resource consumption associated with these outbreaks' Infection Control and Hospital Epidemiology 2009: volume 30, issue 5, pages 467 to 473
115. Bassinet L, Matrat M, Njamkepo E, Aberrane S, Housset B, Guiso N.' Nosocomial pertussis outbreak among adult patients and healthcare workers' Infection Control and Hospital Epidemiology 2004: volume 25, issue 11, pages 995 to 997
116. Baugh V, McCarthy N. 'Outbreak of Bordetella pertussis among oncology nurse specialists' Occupational Medicine 2010: volume 60, issue 5, pages 401 to 405
117. Pascual FB, McCall CL, McMurtray A, Payton T, Smith F, Bisgard KM. 'Outbreak of pertussis among healthcare workers in a hospital surgical unit' Infection Control and Hospital Epidemiology 2006: volume 27, issue 6, pages 546 to 552
118. Alexander E, Travis S, Booms C, Kaiser A, Fry N, Harrison T, and others. 'Pertussis outbreak on a neonatal unit: identification of a healthcare worker as the likely source' Journal of Hospital Infection 2008: volume 69, issue 2, pages 131 to 134
119. Paterson JM, Sheppeard V. 'Nosocomial pertussis infection of infants: still a risk in 2009' Communicable Diseases Intelligence Quarterly Report 2010: volume 34, issue 4, pages 440 to 443
120. Bryant K, Brothers K, Humbaugh K, Kistler V, Stites S, Madeja S, and others. 'Outbreaks of Pertussis Associated with Hospitals--Kentucky, Pennsylvania, and Oregon, 2003' MMWR: Morbidity and Mortality Weekly Report 2005: volume 54, issue 3
121. Nakamura K, Kobayashi M, Yamamoto N, Tokuda K, Miura S, Abe Y, and others. 'Pertussis outbreak among patients and healthcare workers in a provincial dialysis facility in Japan' Journal of Hospital Infection 2016: volume 94, issue 4, pages 341 to 345
122. Elumogo T, Booth D, Enoch D, Kuppuswamy A, Tremlett C, Williams C, and others. 'Bordetella pertussis in a neonatal intensive care unit: identification of the mother as the likely source' Journal of Hospital Infection 2012: volume 82, issue 2, pages 133 to 135
123. Yasmin S, Sunenshine R, Bisgard KM, Wiedeman C, Carrigan A, Sylvester T, and others. 'Healthcare-associated pertussis outbreak in Arizona: challenges and economic

impact, 2011' Journal of the Pediatric Infectious Diseases Society 2014: volume 3, issue 1, pages 81 to 84
124. Sandora TJ, Gidengil CA, Lee GM. 'Pertussis vaccination for health care workers' Clinical Microbiology Reviews 2008: volume 21, issue 3, pages 426 to 434
125. Xie X, Li Y, Chwang A, Ho P, Seto W. 'How far droplets can move in indoor environments–revisiting the wells evaporation–falling curve' Indoor Air 2007: volume 17, issue 3
126. Aintablian N, Walpita P, Sawyer MH. 'Detection of Bordetella pertussis and respiratory syncytial virus in air samples from hospital rooms' Infection Control and Hospital Epidemiology 1998: volume 19, issue 12, pages 918 to 923
127. WHO. 'Global technical consultation report on proposed terminology for pathogens that transmit through the air' (2024)
128. Macina D, Evans KE. 'Pertussis in individuals with co-morbidities: a systematic review' Infectious Diseases and Therapy 2021: volume 10, issue 3, pages 1,141 to 1,170
129. Liu X, Wang Z, Zhang J, Li F, Luan Y, Li H, and others. Pertussis Outbreak in a Primary School in China: Infection and Transmission of the Macrolide-resistant Bordetella pertussis' Pediatric Infectious Diseases Journal 2018: volume 37, issue 6, pages e145 to e148
130. Huang H, Gao P, Gao Z, Wang L, Hao B, Liu Y, and others. 'A big pertussis outbreak in a primary school with high vaccination coverage in northern China: An evidence of the emerging of the disease in China' Vaccine 2018: volume 36, issue 52, pages ,7950 to 7.955
131. Horby P, Macintyre C, McIntyre P, Gilbert G, Staff M, Hanlon M, and others. 'A boarding school outbreak of pertussis in adolescents: value of laboratory diagnostic methods' Epidemiology and Infection 2005: volume 133, issue 2, pages 229 to 236
132. Tessier E, Campbell H, Ribeiro S, Andrews N, Stowe J, Nicholls M, and others. 'Investigation of a pertussis outbreak and comparison of two acellular booster pertussis vaccines in a junior school in South East England, 2019' Eurosurveillance 2021: volume 26, issue 12, page 2000244
133. Edmunds M, Mearkle R, Folliard J, Anderson C, Balasegaram S, Chandra N, and others. 'Retrospective cohort study investigating extent of pertussis transmission during a boarding school outbreak, England, December 2017 to June 2018' Eurosurveillance 2021: volume 26. Issue 26, page 1900736
134. Control CfD, Prevention. 'Use of mass Tdap vaccination to control an outbreak of pertussis in a high school--Cook County, Illinois, September 2006-January 2007' Morbidity and Mortality Weekly Report 2008: volume 57, issue 29
135. Matthias J, Pritchard PS, Martin SW, Dusek C, Cathey E, D'Alessio R, and others. 'Sustained Transmission of Pertussis in Vaccinated, 1-5-Year-Old Children in a Preschool, Florida, USA' Emerging Infectious Diseases 2016: volume 22, issue 2, pages 242 to 246

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