Pertussis (Whooping cough)
Pertussis is an acute upper respiratory tract infection, only found in humans.

The bacterium *Bordetella pertussis* causes pertussis.

These bacteria attach to the cilia (tiny, hair-like extensions) that line part of the upper respiratory tract.

The bacteria release toxins which damage the cilia and cause airways to swell.

Ref: Centres for Disease Control and Prevention (CDC) Pertussis Causes and Transmission (last updated September 8, 2015) Accessed 9th August 2017
How is pertussis spread?

Bordetella pertussis is highly contagious and spreads from person to person through contaminated respiratory droplets (i.e. droplets containing the bacteria):

- when an infected person coughs or sneezes
- via direct contact with secretions from the nose or throat
- droplets can be breathed in by others or passed on by touching a contaminated surface
- people with pertussis are infectious for up to 21 days after the onset of symptoms

Symptoms of pertussis

- Begins with symptoms like a **cold** with **runny nose**, **mild fever** and **a mild cough**

- Develops into a **severe cough** that can last 1-2 months or longer

- Cough followed by a **whooping sound** (whoop may be absent in very young infants, older children and adults)

- **Vomiting** after severe coughing

- **Poor appetite, fatigue and dehydration**

Possible progression of disease

Stage 1 Catarrhal Stage (1-2 weeks)
- runny nose
- fever and
- mild cough

Stage 2 Paroxysmal Stage (1-6 weeks)
- paroxysmal coughing (persistent coughing with sudden onset)
- whoop (inspiration sound after violent bout of coughing)
- vomiting

Stage 3 Convalescent Stage (weeks to months)
- recovery with less coughing

Ref: Centres for Disease Control and Prevention (CDC) Pertussis Clinicians Clinical Features (last updated September 8, 2015) Accessed 9th August 2017
What are the complications of pertussis?

- Pneumonia
- Difficulty breathing
- Seizures or brain damage caused by lack of oxygen to the brain
- Kidney failure
- Vomiting that can lead to weight loss
- Death

Poll 1

What is the most common cause of death in people with pertussis?

A. Acute myocardial infarction due to increased plasma viscosity caused by Bordetella pertussis

B. Pertussis pneumonia, sometimes complicated by seizures and hypoxic encephalopathy

C. Diabetic coma as Bordetella pertussis can cause an increase in blood sugar

D. Kidney failure

Burden of disease

Between 2008 and 2012, the **largest** Australian epidemic since 1991

- **Highest** rates of disease were in children **< 6 months** of age and children **5-9 years** of age

Since 2005, the **highest** annual incidence of **pertussis** was in **2011**

<table>
<thead>
<tr>
<th>Year</th>
<th>Notifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>11154</td>
</tr>
<tr>
<td>2006</td>
<td>9766</td>
</tr>
<tr>
<td>2007</td>
<td>4860</td>
</tr>
<tr>
<td>2008</td>
<td>14295</td>
</tr>
<tr>
<td>2009</td>
<td>30189</td>
</tr>
<tr>
<td>2010</td>
<td>34840</td>
</tr>
<tr>
<td>2011</td>
<td>38758</td>
</tr>
<tr>
<td>2012</td>
<td>24099</td>
</tr>
<tr>
<td>2013</td>
<td>12365</td>
</tr>
<tr>
<td>2014</td>
<td>11864</td>
</tr>
<tr>
<td>2015</td>
<td>22543</td>
</tr>
<tr>
<td>2016</td>
<td>20100</td>
</tr>
</tbody>
</table>

Burden of disease

Some suggested reasons for high notification rates during 2008-2011 epidemic:
• more accessible and sensitive **diagnostic testing** with polymerase chain reaction (PCR)
• **waning of DTPa** vaccine-induced immunity

<table>
<thead>
<tr>
<th>Year</th>
<th>Notifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>14295</td>
</tr>
<tr>
<td>2009</td>
<td>30189</td>
</tr>
<tr>
<td>2010</td>
<td>34840</td>
</tr>
<tr>
<td>2011</td>
<td>38758</td>
</tr>
</tbody>
</table>
Burden of disease

In 2016:

• **20100** cases of pertussis were reported to the National Notifiable Diseases Surveillance System (NNDSS)

• Notification rate of **83 cases per 100,000** population

• **52%** of pertussis notifications were in **children under 15 years** of age

Cases of pertussis in Australia

Notifications of pertussis reported in 2016, varied across states

<table>
<thead>
<tr>
<th>Location</th>
<th>Notifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>504</td>
</tr>
<tr>
<td>NSW</td>
<td>10836</td>
</tr>
<tr>
<td>NT</td>
<td>224</td>
</tr>
<tr>
<td>QLD</td>
<td>2153</td>
</tr>
<tr>
<td>SA</td>
<td>1956</td>
</tr>
<tr>
<td>TAS</td>
<td>30</td>
</tr>
<tr>
<td>VIC</td>
<td>2871</td>
</tr>
<tr>
<td>WA</td>
<td>1526</td>
</tr>
<tr>
<td>Australia</td>
<td>20100</td>
</tr>
</tbody>
</table>

Who is most at risk?

Pertussis can affect **people of any age** including:

- **Babies and young children** are at particularly high risk of complications

- **Older children and adults** may have atypical, less serious disease however cough may continue for many weeks regardless of treatment and may still be associated with morbidity:
  - including sleep disturbance
  - rib fracture and
  - time off work/study

Infants less than 6 months are at greatest risk of severe illness and death

- Children **under one year** of age have a 50% hospitalization rate, 0.5% mortality

- If a **child under 6 months** of age gets whooping cough, they will **usually need to be admitted to hospital**

Who should be vaccinated?

Children and Adolescents

• Pertussis vaccine on National Immunisation Program (NIP) for children 2, 4, 6, 18 months and 4 years of age

• An adolescent booster is available through school immunisation programs at 12-17 years

• Catch-up doses of pertussis containing vaccine is free for individuals 10 to 19 years

### National Immunisation Program

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>2 m*</th>
<th>4 m</th>
<th>6 m</th>
<th>18 m</th>
<th>4 y</th>
<th>12-17 y</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DTPa)#</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
<td>1st booster</td>
<td>2nd booster</td>
<td></td>
</tr>
<tr>
<td>(dTpa)+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3rd booster</td>
<td></td>
</tr>
</tbody>
</table>

*First dose can be given as early as 6 weeks of age

# DTPa= Diphtheria tetanus and acellular pertussis-containing vaccines, which are used in children < 10 years of age. There are six formulations: Infanrix (DTPa), Infanrix hexa (DTPa-hepB-IPV-Hib), Hexaxim (DTPa-hepB-IPV-Hib) Infanrix IPV (DTPa-IPV), Quadracel (DTPa-IPV) and Tripacel (DTPa)

+ dTpa signifies formulations that contain substantially lesser amounts of diphtheria toxoid and pertussis antigens than child (DTPa-containing) formulations. dTpa vaccines are usually used in adolescents and adults. There are four formulations: Boostrix (dTpa), Boostrix-IPV (dTpa-IPV), Adacel (dTpa) and Adacel Polio (dTpa-IPV)
Who should be vaccinated?

Adults

- dTpa vaccine is recommended for **any adult** who wishes to **reduce** the **likelihood** of becoming ill with **pertussis** but is
  - particularly **important** for adults who meet the criteria of a **special risk group**
  - provided free to **refugees and humanitarian entrants** aged over 20 years

Special Risk Groups

Pregnant women
- dTpa is recommended during the **third trimester** of each pregnancy

  - **Optimal time**: between 28 and 32 weeks
  - Can be given at any time during 3rd trimester up to delivery

Benefits
- **protects the newborn** especially in the **first 6 weeks** of life:
  - via **antibodies** that **cross** the **placenta**

Poll 2

Vaccination is recommended in the third trimester of pregnancy which includes:

A. Pregnancies which are closely spaced (<2 years)
B. Pregnancies that occur >2 years apart
C. Boosters post partum every 3 years
D. A and C

Special Risk Groups

Before hospital discharge

• Women who have not received dTpa during pregnancy:
  ➢ Should be vaccinated as soon as possible after delivery

Benefits

• reduce likelihood of pertussis occurring in the mother
  ➢ provide some indirect protection to the infant

Special Risk Groups

Evidence from studies of infant pertussis cases indicates that:

- **household contacts** and carers are frequently the **source** of infection

- with **parents** identified as the source for **more than 50% of cases**

Special Risk Groups

People in contact with infants

Adult **house contacts and carers** (e.g. fathers and grandparents) of **infants < 6 months** of age should receive

- dTpa **at least two weeks before** beginning close contact with infant

- a booster of dTpa if have not received one in previous 10 years

Special Risk Groups

Adults working with young children <4 years of age and
All healthcare workers should receive a
• dose of dTpa vaccine
• a booster dose every 10 years

## Vaccine Formulations

**DTPa**-Diphtheria tetanus and acellular pertussis-containing vaccines, which are used in children < 10 years of age

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Formulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infanrix</td>
<td>DTPa</td>
</tr>
<tr>
<td>Infanrix hexa</td>
<td>DTPa-hepB-IPV-Hib</td>
</tr>
<tr>
<td>Hexaxim</td>
<td>DTPa-hepB-IPV-Hib</td>
</tr>
<tr>
<td>Infanrix IPV</td>
<td>DTPa-IPV</td>
</tr>
<tr>
<td>Quadracel</td>
<td>DTPa-IPV</td>
</tr>
<tr>
<td>Tripacel</td>
<td>DTPa</td>
</tr>
</tbody>
</table>

Poll 3

Infanrix hexa must be reconstituted by adding entire contents of syringe to the vial and shaking until pellet is entirely dissolved. Reconstituted vaccine should be used as soon as practicable, however if storage is required:

A. Store in the fridge for up to 24 hours
B. Hold at room temperature for up to 24 hours
C. Store in the fridge for up to 8 hours
D. Hold at room temperature for up to 8 hours

**Vaccine Formulations**

*dTpa* formulations that contain substantially **lesser amounts** of **diphtheria** toxoid and **pertussis** antigens than child (**DTPa**-containing) formulations

*dTpa* vaccines are usually used in **adolescents and adults**

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Formulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boostrix</td>
<td>dTpa</td>
</tr>
<tr>
<td>Boostrix-IPV</td>
<td>dTpa-IPV</td>
</tr>
<tr>
<td>Adacel</td>
<td>dTpa</td>
</tr>
<tr>
<td>Adacel Polio</td>
<td>dTpa-IPV</td>
</tr>
</tbody>
</table>

Vaccine efficacy

A 3-dose primary series of immunisation with DTPa vaccine at 2, 4 and 6 months of age results in:

- **84% protective efficacy** against severe disease

Vaccine efficacy

- Immunity to pertussis wanes over time
- Effectiveness of three doses declined progressively from 2 years of age to less than 50% by 4 years of age

Vaccine efficacy

- A large trial in adolescents and adults demonstrated overall vaccine efficacy against confirmed pertussis of 92% within 2.5 years of vaccination.

Vaccinating pregnant women
Is there evidence to support this?

Vaccinating pregnant mothers in UK at least 7 days before delivery:

- **Reduced pertussis disease by 91% in infants <3 months of age**

Cocoon Vaccination
Is there evidence to support?

Emerging data on the **effectiveness** of indirect **protection to infants** from the **cocoon approach** suggest:

- modest benefit

- **50% reduction in pertussis** disease in young infants **when both parents were vaccinated at least 4 weeks before disease onset** in the infant

Vaccine Safety

Compared to whole-cell pertussis vaccines (DTPw), **acellular pertussis vaccines** are associated with a much lower incidence of:

- **Fever** (20% vs 45%)
- **Local reactions** (10% vs 40%)

Extensive **limb swelling** can occur with **booster doses of DTPa**.
Such reactions commence within 48 hours of vaccination,
- last 1-7 days and
- **resolve completely**

Vaccine Safety

Pregnancy
Studies show:
• no increased risk of pregnancy outcomes such as stillbirth, pre-eclampsia, foetal distress, low birth weight or neonatal renal failure related to pertussis vaccination during pregnancy

Vaccine contraindications

The only absolute contraindications to acellular pertussis-containing vaccines are:

• anaphylaxis following a previous dose of any acellular pertussis-containing vaccine

• anaphylaxis following any vaccine component

Treatment to prevent disease transmission

Pertussis is treated with:
• usually azithromycin for 5 days or
• clarithromycin for 7 days or
• Trimethoprim + sulfamethoxazole for 7 days

What do antibiotics do?
• prevent the spread of pertussis to other people
• effectively eliminate B. pertussis, the evidence that they alter the course of the disease is not conclusive

If coughing longer than three weeks:
• rarely infectious
• antibiotics not needed

Prophylaxis of pertussis contacts

Recommend antibiotic prophylaxis for:

- children < 6 months in contact with pertussis cases or
- people who may transmit pertussis to these infants
- children <2 years of age
- women in last month of pregnancy

Use same antibiotic regimen as for treatment to prevent disease transmission

Conclusions

- Pertussis is a **very contagious** respiratory infection caused by *Bordetella pertussis*

- The major symptom of pertussis is the characteristic **cough**, which is often followed by a **whooping** sound on inhalation

- **Infants less than 6 months** of age are at greatest risk of **severe illness and death**

- Free pertussis vaccination is available under NIP for children **2, 4, 6** and **18 months** and **4 years of age**. A booster is also available through the schools for **adolescents** (12-17 years of age), **10 – 19 year old** catch up program

- To reduce pertussis in infants, vaccination is recommended for their **close contacts, healthcare workers** and **pregnant women**