Introduction
Immunisation is one of the most effective disease prevention strategies in children. In this process, an antigen is introduced into the body, where it stimulates immunity against the specific antigen by priming the specific memory cells. Subsequent natural infection produces an effective and vigorous response by the body, and the patient is thus protected from the disease and its effects and complications.

In 1974, the World Health Organization (WHO) initiated the Expanded Programme on Immunisation (EPI). This aims to develop widespread national commitment to achieve high vaccination coverage in mostly low-income countries. The choice of the original six EPI vaccines was based on the importance of the disease and the availability of safe, efficacious and low-cost vaccines.

The WHO recommended vaccination schedule is widely used in almost all countries, with newer vaccines being added as some programmes evolved (see Table 1.17.1).

<table>
<thead>
<tr>
<th>Age</th>
<th>Vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>BCG*, OPV#0, HBV#1</td>
</tr>
<tr>
<td>6 weeks</td>
<td>DTP#1, HIB#1, OPV#1, HBV#2 PCV#1</td>
</tr>
<tr>
<td>10 weeks</td>
<td>DTP#2, HIB#2, OPV#2, HBV#3 IPV#1</td>
</tr>
<tr>
<td></td>
<td>PCV#2 RV#2</td>
</tr>
<tr>
<td>14 weeks</td>
<td>DTP#3, HIB#3, OPV#3, IPV#2 PCV#3</td>
</tr>
<tr>
<td>9 months</td>
<td>MCV/RCV #1</td>
</tr>
<tr>
<td></td>
<td>Yellow fever (in countries where it poses a risk)</td>
</tr>
<tr>
<td>12–15 months</td>
<td>MCV/RCV#2</td>
</tr>
<tr>
<td>9 years</td>
<td>HPV#1 plus HPV# 2 after at least 6/12</td>
</tr>
</tbody>
</table>

*BCG must not be given if HIV infection is present or clinically suspected

See these links for further information:
- www.who.int/immunization/policy/immunization_tables/en/
- www.who.int/immunization/policy/Immunization_routine_table2.pdf?ua=1

Vaccine schedules are a continuously changing phenomenon. It is recommended that regional variations on programmes are followed.

Polio
Live oral poliovirus vaccine (OPV) and inactivated poliovirus vaccine (IPV) are the two effective vaccines that are available, but there are important differences between them.
- WHO no longer recommends an OPV only vaccination schedule, at least 1 dose of IPV should be added to the schedule.
- In polio-endemic countries and in countries at high risk for importation and subsequent spread, WHO recommends an OPV birth dose (a zero dose) followed by a primary series of 3 OPV and at least 1 IPV doses.
- The WHO target to eradicate poliomyelitis within the next 10 years is dependent on high infant immunisation coverage and national immunisation days (NIDs), which aim to eradicate the circulation of wild virus. NIDs are designed to complement routine immunisation by targeting the most vulnerable individuals in as short a time period as possible. OPV is given over a 2-day period, 1 month apart, and the NIDs are repeated annually for at least 3 years.

Pertussis
Fever and mild local reactions are common. Consider a two-dose schedule for those areas where services can be provided only twice a year.

Measles
Accelerated implementation of strategies to reduce the burden of measles is required. Targeting children under 5 years of age in major cities is a priority. Strategies to reduce the impact of infant measles include:
- increasing coverage to the 9–23 months age group
- a two-dose schedule at 6 months and 15 months is most appropriate for epidemic situations, and a two-dose
schedule at 9 months and 15 months is currently recommended routinely.

Tetanus
All healthcare workers at antenatal clinics should guarantee that no women attending will have a child who dies of neonatal tetanus, by giving immunisation and advice about umbilical cord care. Vaccination of young adolescent girls is recommended in areas with poor antenatal coverage. Mothers who were not seen antenatally should be vaccinated when they bring their infants to clinic.

BCG
This offers good protection against disseminated tuberculosis and also affords some protection from leprosy. Where the risk of tuberculosis is high, BCG is recommended at birth or as soon as possible thereafter. It is recommended for children living in countries with a high-disease burden for HIV and for high-risk children living in countries with low-disease burden.

Children who are HIV positive or have unknown HIV status with symptoms consistent with HIV should not be vaccinated.

New vaccines and EPI
Hepatitis B and yellow fever vaccines have been recommended since 1992. The Hib vaccine is also a priority, and is given as combination now in EPI programmes with the DPT and HBV as three doses. Newly introduced vaccines are the pneumococcal conjugate vaccine (PCV) and the rotavirus vaccines. Unfortunately there is no vaccine yet available against HIV or hepatitis C.

Other vaccines to consider based upon local epidemiology and resource limitations would be:
- MMR (Measles, Mumps and Rubella) vaccine instead of MCV/RCV as at present recommended
- Typhoid vaccine
- Varicella vaccine
- Meningococcal (Conjugate) vaccine.

Contraindications to immunisation
All vaccines
- Anaphylactic reaction.
- Moderate to severe acute illnesses with or without fever.
- Evolving neurological disease.

Specific vaccines
- Encephalopathy (DPT/DaPT).
- Immundeficiency (OPV, BCG, MMR).
- Anaphylactic reaction to egg and neomycin (MMR, ZVZ).
- Pregnancy (MMR, OPV, IPV).
- Precautions for DPT:
  - fever > 105 °F
  - collapse or shock-like state
  - seizures
  - persistent inconsolable crying.

Conditions that are not contraindications to immunisation
- Minor illnesses, such as upper respiratory infections or diarrhoea, with fever < 38.5 °C.
- Allergy, asthma or other atopic manifestations (e.g. hay fever, "snuffles").
- Prematurity, small-for-date infants.
- Malnutrition.
- Child being breastfed.
- Family history of convulsions.
- Convalescent phase of illness.
- Penicillin or other allergies.
- Treatment with antibiotics, low-dose corticosteroids or locally acting (e.g. topical or inhaled) steroids.
- Dermatoses, eczema or localised skin infection.
- Chronic diseases of the heart, lung, kidney or liver.
- Stable neurological conditions (e.g. cerebral palsy, Down's syndrome).
- History of jaundice after birth.

HIV infection and vaccination
Individuals with known or suspected asymptomatic HIV infection should receive all EPI vaccines (including against rotavirus) as early in life as possible according to nationally recommended schedules. Because of the risk of early and severe measles, infants should receive a standard dose at 6 months, with a second dose as soon after age 9 months as possible.

Children who are HIV positive or have unknown HIV status with symptoms consistent with HIV should not be vaccinated with BCG.

Also see Sections 2.8.C and 6.2.D HIV Infection.

TABLE 1.17.2 WHO/UNICEF recommendations for the immunisation of HIV-infected children and women of childbearing age

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>HIV positive without symptoms</th>
<th>HIV positive with symptoms</th>
<th>Optimal timing of immunisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>No</td>
<td>No</td>
<td>6, 10 and 14 weeks</td>
</tr>
<tr>
<td>DPT</td>
<td>Yes</td>
<td>Yes</td>
<td>0, 6, 10 and 14 weeks</td>
</tr>
<tr>
<td>OPV</td>
<td>Yes</td>
<td>Yes</td>
<td>6 and 9 months</td>
</tr>
<tr>
<td>Measles</td>
<td>Yes</td>
<td>Yes</td>
<td>As for uninfected children</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Yes</td>
<td>Yes</td>
<td>6, 10 weeks</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>Yes</td>
<td>Yes</td>
<td>(No pending further studies)</td>
</tr>
<tr>
<td>Yellow fever</td>
<td>Yes</td>
<td>(No pending further studies)</td>
<td>—</td>
</tr>
<tr>
<td>Tetanus toxoid</td>
<td>Yes</td>
<td>Yes</td>
<td>5 doses</td>
</tr>
</tbody>
</table>

Additional vaccines that should be seriously considered in HIV-infected children include the following:
- Varicella vaccine:
  - recommended in asymptomatic/mildly symptomatic children
  - two doses should be given with a 3-month interval

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— strongly recommended for HIV-negative siblings and other children in the household
— contraindicated in moderately and severely immunocompromised children.

- Other vaccines:

<table>
<thead>
<tr>
<th>Vaccines</th>
<th>Shelf life</th>
<th>Transport state-district</th>
<th>State/district</th>
<th>Transport to PHC</th>
<th>PHC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTP/TT and typhoid</td>
<td>1–1.5 years (4–8°C)</td>
<td>+4 to +8°C</td>
<td>3 months (4–8°C)</td>
<td>4–8°C</td>
<td>1 month (4–8°C)</td>
</tr>
<tr>
<td>BCG</td>
<td>8 months (4–8°C)</td>
<td>+4 to +8°C</td>
<td>3 months (4–8°C)</td>
<td>4–8°C</td>
<td>1 month (4–8°C)</td>
</tr>
<tr>
<td>Measles and OPV</td>
<td>2 years at –20°C</td>
<td>–20°C to +8°C</td>
<td>3 months (–20°C)</td>
<td>–20°C to +8°C</td>
<td>1 month (4–8°C)</td>
</tr>
</tbody>
</table>

**Logistic actions** to avoid unnecessary risk, vaccine wastage and missed opportunities are essential.

**Immunisation instruments recommended by EPI**

Disposable single-use plastic syringes are safe and economical, but it is important to correctly destroy and dispose of the syringes and sharps after use. Used needles and syringes should be placed in a hard container, sealed, autoclaved, and ideally incinerated for disposal.

- Opened vials of OPV, DPT and hepatitis B vaccines may be used in subsequent immunisation sessions until a new shipment arrives (provided the expiry date has not passed, vaccines are kept in the cold chain and the vials have not been used outside the health centre).
- Opened vials of measles, yellow fever and BCG vaccines must be discarded at the end of each immunisation session.
- Vaccine vial monitors (VVMs) will enable field staff to reject vials of vaccine that are heat damaged.
- Screen and immunise at every contact. The rate of non-immunisation of eligible children at clinics may be as high as 30%.
- Reduce wastage by choosing the correct vial size.
- Ensure appropriate use of the vaccine cold box. Cold boxes only work if they are kept cold with the lid tightly shut. Ice packs are placed in the bottom and around the sides of the box and on the top of the vaccines. Newspaper should be placed between the vaccines and the ice packs to protect DPT and tetanus vaccines from the ice. A thermometer should be placed with the vaccines to record the temperature of the vaccines when they are removed from the cold box. The diluent that is used to reconstitute measles and BCG vaccine must also be kept cold.
- Effective supervision requires focus on the essentials.
- Evaluate and monitor the programme.

**Care of refrigerators**

A constant supply of electricity, gas or kerosene is required. The electric plug can be taped to its socket to ensure that it is not inadvertently removed. For gas and kerosene fridges, a reserve full bottle of gas or can of fuel should always be present. A regulator valve should be used with the gas bottle. Kerosene tanks should be filled daily using a funnel and filter to remove dirt. The refrigerator should be positioned in a completely upright position with a draught blowing on the temperature exchanger to keep it cool. A fan can be used for this if there is no wind and the ambient temperature is high.

**Summary**

- Vaccines are the best form of prevention, especially for children under 5 years of age.
- They are safe, effective, generally economical, and easily available.
- Immunisation of a child should start at birth and continue until they are old enough to attend college.
- Standards must be maintained with regard to procurement, delivery, storage and administration of all vaccines.
- In the event of missed doses, in most cases the vaccination schedule can be completed from the time when the dose was missed.
- Mild fever and upper respiratory tract infections are not contraindications to giving vaccination.
- Do take every opportunity to recommend vaccination for children.

**Immunisation issues in pregnancy**

**Vaccination against tetanus**

The most important vaccination that should be given to all pregnant women and girls is to prevent tetanus in women and in the newborn infant. After two doses, protective antibodies are present in more than 80% of recipients. The vaccine is safe in pregnancy, and two doses of vaccination last for at least 3 years.

If the woman or girl has a tetanus-susceptible wound, including following an unsafe abortion, protect against future tetanus risks by immunising her immediately if she is not already protected. In addition, provide prophylaxis with tetanus immunoglobulin if the wound is large and possibly infected with soil or instruments contaminated with animal excreta.

In the antenatal setting, check the immunisation status of the pregnant woman (either by a history or from the record card), regardless of whether she intends to continue the pregnancy.

If the woman has not previously been vaccinated, or her immunisation status is unknown, give two doses of TT/Td 1 month apart as soon as possible before delivery; TT1 and TT2 (one dose is not enough to give protection to the mother or newborn baby). Two doses protect for 1 to 3 years. If there is time in the remainder of the pregnancy, give another dose, TT3, 6 months after the second initial dose; otherwise give the third dose, TT3, in the next pregnancy. Three doses protect for at least 5 years. A fourth dose; otherwise give the third dose, TT3, in the next pregnancy. Three doses protect for at least 5 years. A fourth
dose can be given at least 1 year after TT3, and protects for at least 10 years.

If the woman can prove her previous vaccination history, and provided she has had between 1 and 4 doses in the past, give one additional dose before delivery.

Before giving the vaccine, shake the vial and make sure that the material in the base of the vial is completely mixed with the liquid. If it is suspected that the vaccine has been frozen and thawed, this mixing may not occur and the vial should not be used.

If neonatal tetanus occurs, give the mother one dose of TT as soon as possible, and repeat the dose 4 weeks later and then again 6 months after the second dose.

Record the doses given on a central hospital/clinic register. However, it is of paramount importance to record them on a card or maternal health record kept by the mother.

**Immunisation against hepatitis B virus (HBV)**

All pregnant women and girls should ideally be offered screening for HBV.

They may have become infected at their birth (vertical transmission) or by sexual contact or through infected blood transfusion or use of dirty needles. Hepatitis B can be passed from a mother to her baby during or shortly after delivery. Having a Caesarean section does not prevent the virus from being transferred to the baby. If a ventouse delivery is undertaken a soft cap is preferred to the metal cup. Breastfeeding is safe.

During pregnancy, all women should have a blood test for a marker of hepatitis B virus, which is called hepatitis B surface antigen (HBsAg). Normally the HBsAg should be negative.

If a pregnant woman’s HBsAg test or hepatitis B e-antigen (HBeAg) test are positive, the infant must be given hepatitis B immunoglobulin (HBIG) as soon as possible after birth to reduce the transmission rate from 70–90% to 5–10%.

Similarly, if a woman develops HBV infection during pregnancy, HBIG prophylaxis (400IU given intramuscularly), which is safe, should be administered urgently within 24 hours of infection if possible. Acute HBV infection may be asymptomatic or present with signs of acute hepatitis. If available, antiviral therapy can be given to pregnant women who have high viral loads.

HBIG provides immediate protection for the woman or infant, but the effect only lasts a few months. Women or their babies should then be given a course of HBV vaccination (the initial dose being given at the time of HBIG, and then two further doses at 1 and 6 months after the initial dose).

The newborn infant, in addition to receiving the HBIG described above, should receive the hepatitis B vaccine at birth, again at 1–2 months, and finally at 6 months of age.

It is important to complete all three doses for long-term protection. The infant should have a blood test for hepatitis B infection and for hepatitis B antibody at 9–18 months of age. If the antibody test is negative, a fourth dose of the vaccine should be given at that time.

Women who are HBsAg-positive must not donate breast milk.

**Vaccinations that should not be given during pregnancy**

**Live vaccines**
- BCG (live attenuated strain).
- Oral typhoid vaccine.
- Measles–mumps–rubella (MMR).
- Rotavirus.

**Inactivated vaccines**
- Oral cholera.
- 7-Valent pneumococcal conjugate.

WHO recommendations for Immunisation of Health Care Workers:

**Hepatitis B.** Immunisation is suggested for groups at risk of acquiring infection who have not been vaccinated previously (for example HCWs who may be exposed to blood and blood products at work).

**Polio.** All HCWs should have completed a full course of primary vaccination against polio.

**Diphtheria.** Particular attention should be given to revaccination of HCWs with diphtheria boosters every 10 years. Special attention should be paid to immunising HCWs who may have occupational exposure to *C. diphtheria*.

**Measles.** All HCWs should be immune to measles and proof/documentation of immunity or immunization should be required as a condition of enrolment into training and employment.

**Rubella.** If rubella vaccine has been introduced into the national programme, all HCWs should be immune to rubella and proof/documentation of immunity or immunisation should be required as a condition of enrolment into training and employment.

**Meningococcal disease.** One booster dose 3–5 years after the primary dose may be given to persons considered to be at continued risk of exposure, including HCWs.

**Further reading**

Vaccines and vaccination against yellow fever. WHO Position Paper – June 2013 [www.who.int/wer/2013/wer8827.pdf](http://www.who.int/wer/2013/wer8827.pdf)