In some circumstances, advice in these guidelines may differ from that in the Summary of Product Characteristics (SmPC). When this occurs, the recommendations in these guidelines, which are based on current expert advice from NIAC, should be followed.

This chapter has the following sections
• Introduction
• General Principles of Immunisation of Immunocompromised Persons
• Cancer patients
• Transplantation
  - Haematopoietic Stem Cell Transplant
  - Solid organ transplant candidates and recipients
• Corticosteroid therapy
• Immunomodulatory treatment
• Functional or anatomic asplenia, hyposplenism
• HIV
• Primary Immunodeficiency
• Immunocompetent household contacts of immunocompromised persons

Introduction
The number of children and adults with impaired immune function due either to their condition (e.g. primary immunodeficiency, asplenia, HIV infection) or treatment (cancer chemotherapy, corticosteroid, antimetabolite or biologic immunomodulator therapy) is increasing. These groups need specific consideration with regards to immunisation. This chapter outlines basic principles and makes recommendations for certain groups with altered immunity.
Chapter 3  Immunisation of Immunocompromised Persons

Further details about individual vaccines can be found in the specific chapters.

**General Principles of Immunisation of Immunocompromised Persons**

Immunocompromised persons are at increased risk from vaccine preventable diseases and should receive appropriate vaccines.

A review of immunisation status and administration of required vaccines should be an integral part of the assessment pre transplant or before starting immunomodulatory treatment.

Non-live vaccines can be given but recipients may not develop an adequate protective response, depending on the degree of immune suppression at the time of immunisation.

With some important exceptions (see text) live vaccines should not be given to immunocompromised persons.

For complex cases, relevant specialist advice should be sought from an appropriate physician.

**Cancer patients**

The risks of vaccine preventable disease in cancer patients vary depending on exposure, vaccination history and the degree of immunosuppression. The likelihood of beneficial response to vaccination varies depending on disease stage and degree of immunosuppression.

When possible, recommended vaccines should be given before treatment.

As a rule, patients on treatment for haematologic malignancy are more immunosuppressed than those with solid tumours.

In general, cancer patients can safely receive non-live vaccines, whereas live vaccines are generally avoided. Avoid vaccination during periods of intense chemotherapy as vaccine responses are likely to be significantly attenuated. In some situations the benefits of live vaccines can outweigh any potential risk, e.g. varicella for susceptible leukaemia patients who are in remission and post chemotherapy. If non-live vaccines are given during chemotherapy, these should be re-administered when there is recovery of immune function, usually 6 months post chemotherapy.

Re-administration of vaccines given prior to chemotherapy is generally not necessary except where chemotherapy is followed by haematopoietic stem transplantation (HSCT).
Chapter 3 Immunisation of Immunocompromised Persons

Recommendations

• When possible, complete immunisation prior to therapy, as response will be attenuated during chemotherapy.

• Consider Tdap for all adult patients.

• Pneumococcal vaccination is recommended for all cancer patients. Ideally, vaccinate before chemotherapy
  - For patients who have never received PCV or PPV23, give a single dose of PCV followed by PPV23 after a minimum interval of 8 weeks.
  - For patients who have received 1 or more doses of PPV23, give a single dose of PCV at least 1 year after the PPV23 was received.
  - Children who have received PCV7 should also receive PCV13 and PPV23 (see Pneumococcal chapter for immunisation of high risk children).
  - A booster dose of PPV23 should be given at least 5 years after the previous dose if still immunosuppressed or when 65 years of age.

• Hib is not routinely recommended for adult cancer patients unless undergoing HSCT (Table 3.1).

• Annual seasonal inactivated influenza vaccine is recommended for all cancer patients. Give after a minimum interval of 3 to 4 weeks following a course of chemotherapy and when lymphocyte count is $> 1000 \times 10^9/L$. As vaccine response may be blunted, in case of a definite influenza exposure, additional chemoprophylaxis may be warranted.

• Polio, MenB, MenC, MenACWY, HAV, HBV and HPV can be given if indicated.

• In general, cancer patients should not receive MMR. However, MMR can be given to patients with leukaemia or lymphoma if they are in remission and have been off chemotherapy for 6 months. Where there is high risk of infection the minimum interval post chemotherapy for administration of MMR is 3 months.

• Susceptible persons with leukaemia, lymphoma or other malignancies who are in remission, who are off chemotherapy for a minimum of 3 and generally for 6 months and who are considered at high risk for severe or complicated varicella, can receive varicella vaccine. It should be given under specialist supervision and with an appropriate protocol in place for the management of vaccine virus infection (which may occur in up to 20% cases).

• BCG, as vaccination against TB is not recommended for cancer patients.
Chapter 3  Immunisation of Immunocompromised Persons

Transplantation
Non-live vaccines can generally be initiated 6 months after haematopoietic stem cell transplant (HSCT) or solid organ transplantation (SOT). However, depending on degree of immune suppression, vaccine responses may be suboptimal.

Vaccination should be deferred for those receiving immunoglobulin (IVIG), or with graft versus host disease. Live vaccines should be deferred for at least 2 years after HSCT and only given if there is no graft versus host disease or ongoing immunosuppressive treatment, the CD4 count is > 400 x10^6/L and IgM > 0.5g/l. Live vaccines are generally contraindicated post SOT as these patients are likely to remain on immunosuppressive therapy.

BCG is contraindicated following SOT and is not indicated after HSCT.

Haematopoietic Stem Cell Transplant (HSCT)
Both autologous and allogeneic HSCT recipients are at risk of developing infectious complications during the period of immune reconstitution. HSCT recipients initially have profound humoral and cell-mediated immunodeficiency, but gradually become capable of functional B and T cell responses. The CD4 count provides a reasonable guide to recovery of the immune system. The degree of immunosuppression and the speed of recovery of immune competence depend on age at transplantation, underlying diagnosis, dose intensity, duration of treatment before transplantation, and the transplantation conditioning regime.

Recommendations
• Recommended vaccinations and schedule following HSCT are shown in Table 3.1.
• Vaccination with non-live vaccines should commence 6 months post transplant.
• Given the high risk of pneumococcal disease in the post transplant patient, PCV vaccination may be given as early as 3 months post transplant.
• **BCG is not indicated post transplant.**
• Post vaccination testing of HSCT patients may be considered every 5 years to assess immunity to HBV, measles, tetanus, diphtheria and polio.

Table 3.1 below outlines a schedule which can be tailored for different scenarios, but recommended minimum intervals between vaccines must be observed (see Chapter 2).
### Table 3.1. Vaccinations following HSCT

<table>
<thead>
<tr>
<th>Months post transplant</th>
<th>IMMUNISATION SCHEDULE following HSCT</th>
<th>Age</th>
<th>&lt; 10 years</th>
<th>≥10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months</td>
<td>6 in 1 + PCV</td>
<td></td>
<td>4 in 1 + PCV + Hib</td>
<td></td>
</tr>
<tr>
<td>7 months</td>
<td>MenACWY + MenB</td>
<td></td>
<td>MenACWY + MenB + Hepatitis B</td>
<td></td>
</tr>
<tr>
<td>8 months</td>
<td>6 in 1 + PCV</td>
<td></td>
<td>4 in 1 + PCV + Hib</td>
<td></td>
</tr>
<tr>
<td>9 months</td>
<td>MenACWY + MenB</td>
<td></td>
<td>MenACWY + MenB + Hepatitis B</td>
<td></td>
</tr>
<tr>
<td>10 months</td>
<td>6 in 1 + PCV</td>
<td></td>
<td>4 in 1 + PCV + Hib</td>
<td></td>
</tr>
<tr>
<td>11 months</td>
<td>MenACWY</td>
<td></td>
<td>MenACWY</td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>PPV23 or PCV 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>HPV5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 months</td>
<td>HPV + Hepatitis B3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 months</td>
<td>HPV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 months</td>
<td>MMR6 (2 doses, 1 month apart)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 24 months</td>
<td>Consider varicella vaccine 7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>Inactivated influenza, initiate 6 months post transplant, 2 doses four weeks apart then 1 dose annually</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 4 years post transplant</td>
<td>DTaP/IPV (3 years after 3rd 6 in 1)</td>
<td></td>
<td>Tdap/IPV (3 years after 3rd 4 in 1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tdap (10 years later)</td>
<td></td>
<td>Tdap (10 years later)</td>
<td></td>
</tr>
</tbody>
</table>

1 DTaP/IPV/Hib/HepB
2 DTaP/IPV
3 Test for anti-HBs antibody 2 months after completion of HBV vaccination. A second three-dose Hepatitis B vaccination course is recommended for non responders.
4 For patient with chronic graft versus host disease (GVHD) substitute a fourth dose of PCV for PPV23, as patients with GVHD are unlikely to mount protective responses to polysaccharide vaccines. PPV23 can be given after resolution of GVHD and at least 8 weeks following PCV.
5 For females up to 45 and males up to 26 years.
6 If no GVHD or immunosuppression
7 If no GVHD or immunosuppression.
Chapter 3  Immunisation of Immunocompromised Persons

Solid organ transplant (SOT) candidates and recipients

Recommendations

Recommended vaccinations pre and post SOT are shown in Table 3.2.

Pre transplant:
When possible complete age appropriate immunisation prior to therapy (if necessary use the minimum intervals given in Chapter 2).

- Live vaccinations, other than BCG, can be given pre-transplant but not within 1 month of the transplant, and not to those receiving immunosuppressive therapy.

- Children and adults who did not receive BCG in infancy do not require BCG pre transplant and should not receive it post transplant.

- Immunisation with non-live vaccines should be completed at least 2 weeks prior to transplant as they are unlikely to induce protective responses if given after this time.

- Ideally patients should also receive PCV, PPV23, varicella, MenACWY, MenB, Hepatitis A and B vaccines.

- MMR vaccine can be given from 6 months of age and should be given early if transplant before 13 months of age is anticipated.

- Patients aged 10 years and over should receive vaccinations as recommended in Table 2.3 of Chapter 2.

- Patients 6 months of age and over should receive annual inactivated influenza vaccination.

Post transplant:

- Non-live vaccines can be given from 6 months post transplant. If immunisation is not completed pre-transplant, the course should be completed post transplant.

- Those who receive non-live vaccines within 2 weeks prior to transplant should be re-immunised not sooner than 6 months post transplant.

- Live vaccines are generally not given post transplant as these patients are likely to remain on immunosuppressive therapy.

- **BCG should never be given post SOT.**

- Patients older than 6 months of age should receive annual Inactivated influenza vaccination.
Table 3.2 Vaccinations for SOT candidates and recipients aged 10 years and over.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Pre-SOT</th>
<th>Post-SOT, if immunisation not completed pre transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inactivated influenza</td>
<td>Yes</td>
<td>Yes (annual)</td>
</tr>
<tr>
<td>Hep A (susceptible patients)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hep B (if HBsAg negative &amp; Anti-HBs&lt;100miu/L)</td>
<td>Yes</td>
<td>Yes (i.e. HBVAXPRO40 or Fendrix)</td>
</tr>
<tr>
<td>HPV</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MenACWY</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>MenB</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PCV</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PPV23 (2 months post PCV)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tdap or Tdap/IPV</td>
<td>Yes</td>
<td>Yes, if not received within 10 years Use if not fully immunised with IPV</td>
</tr>
<tr>
<td>MMR (unless laboratory evidence of immunity or documented prior vaccination)</td>
<td>Yes (complete at least 1 month prior to transplant)</td>
<td>No</td>
</tr>
<tr>
<td>Varicella (seronegative patients)</td>
<td>Yes (complete at least 1 month prior to transplant)</td>
<td>No</td>
</tr>
</tbody>
</table>

Corticosteroid therapy

Neither the dose nor duration of systemic corticosteroids that cause immune suppression nor the duration of altered immunity following cessation of therapy are well defined.

Daily receipt of high dose corticosteroids is potentially immunosuppressive. The following doses of prednisolone (or equivalent dose of other glucocorticoid) are likely to be immunosuppressive

- Adults and children >40kg: More than 20mg/day for 2 weeks or longer
- Children <40 kg: 0.5mg/kg/day or more for 2 weeks or longer

Recovery of immune competence is dependent on the dose, frequency of administration (daily or alternate day) and duration of therapy. Ideally,
complete immunisation prior to steroid initiation. Timing of immunisation following steroid therapy is influenced by the expected degree of immune suppression and the urgency of vaccination.

It is generally accepted that live virus vaccines can be given from 3 months after cessation of high dose steroid therapy, with some experts recommending their administration as soon as 1 month after their cessation.

**Recommendations**

- When possible complete age appropriate immunisation prior to high dose steroid therapy.
- Non-live vaccines can safely be given to patients receiving steroids, however protective responses may be blunted. If concerned, re-immunisation 1 to 3 months post steroid therapy is recommended.
- Patients receiving potentially immunosuppressive steroid therapy should not be given live vaccines.
- Defer live virus vaccines for a minimum of 1 month, and where circumstances permit 3 months, after stopping high dose steroid therapy.
- Defer BCG for a minimum of 3 and generally 6 months after stopping high dose corticosteroid therapy.
- Defer BCG until after 3 months of age for infants born to mothers who received high dose steroid therapy for two weeks or more in the second or third trimester.
- There are no contraindications to using live vaccines, bacterial or viral, if steroid treatment is:
  - short term (<14 days) irrespective of dose
  - long term with less than 20mg of prednisolone (0.5mg/kg in children <40kg) or equivalent per day
  - long-term, alternate-day treatment with short-acting preparations
  - maintenance physiologic doses (replacement therapy)
  - topical (skin or eyes) or by inhalation
  - intra-articular, bursal, or tendon injection.
  - fludrocortisone ≤300 micrograms/day
Immunomodulatory treatment

Immunomodulatory treatment includes alkylating agents (e.g. cyclophosphamide, chlorambucil), antimetabolites (e.g. methotrexate, azathioprine), T cell immunosuppressants (e.g. cyclosporine, tacrolimus, sirolimus) or biologic response modifiers (e.g. adalimumab, infliximab, rituximab).

Patients with Immune Mediated Inflammatory Diseases IMID (e.g. juvenile idiopathic arthritis, rheumatoid arthritis, systemic lupus erythematosus, and inflammatory bowel disease) are at increased risk of vaccine preventable diseases because of the disease process and the effects of treatment.

Non live vaccines are safe but protective responses may be blunted if given while immunosuppressed.

Live vaccines should not be given while patients are receiving immunosuppressive therapy. There is no strong evidence on which to base recommendations for their use following cessation of therapy and decisions should be made taking into account the likely duration of immunosuppression. Some agents have a relatively short duration of action (e.g. etanercept) whereas with others (e.g. rituximab) the effects can last for months after discontinuation of therapy. Increasingly, combinations of agents are used which can result in very significant immunosuppression.

Topical use of tacrolimus for atopic dermatitis in otherwise healthy children does not result in significant systemic absorption. The immunogenicity of non-live vaccines in children being treated with topical tacrolimus for atopic dermatitis is likely to be satisfactory. Concern for potential systemic absorption resulting in possible immune suppression has led to some authorities advising avoidance of live vaccines for 28 days before initiation and after cessation of topical tacrolimus. If immunisation with live vaccines is more urgently required, serum tacrolimus levels can be checked to exclude significant absorption and vaccination undertaken under specialist supervision.

Recommendations

- When possible complete age appropriate immunisation prior to therapy. Non-live vaccines may safely be administered during treatment. However as the response can be attenuated, such vaccines given in the 2 weeks immediately prior to therapy or during therapy should be repeated when off immunosuppressive therapy for at least 6 months and when immune competence is restored.
- Live vaccines should be given at least one month before the start or restart of immunotherapy when off other immunosuppressive therapy.
Chapter 3  Immunisation of Immunocompromised Persons

for a minimum of 3- 6 months, depending on the severity of anticipated immunosuppression. Discussion with the treating physician is advised.

• Defer live vaccines for a minimum of 6 months after anti-CD20 treatment (i.e. rituximab) and until B cell recovery.

• Defer BCG vaccination until after 6 months of age for infants born to mothers who received immunomodulatory treatment other than short course steroids in the second or third trimester.

• Non-live vaccines can safely be given to patients being treated with topical tacrolimus. Live vaccines, either within 28 days before or after treatment, should be used under specialist supervision (see above).

• Varicella vaccine is recommended for susceptible patients and the course completed at least 4 – 6 weeks prior to treatment.

• MenACWY and MenB are recommended for those receiving eculizumab (Soliris) which is associated with increased risk of meningococcal disease.

• Interferon therapy is not a contraindication to live vaccines. However, to avoid the potential for drug side effects being confused with a vaccine reaction, deferral of vaccination until after treatment is completed is prudent.

Functional or anatomic asplenia and hyposplenism

Individuals with functional or anatomic asplenia or hyposplenism are at increased risk of fulminant bacteraemia, particularly from pneumococcus but also from other encapsulated polysaccharide bacteria (e.g. Hib, meningococcus). Hyposplenism is associated with a number of conditions, including sickle cell disease, thalassemia, coeliac disease, Inflammatory Bowel Disease, SLE, and HIV/AIDS. In addition to all routine immunisations all hyposplenic and asplenic patients should be fully immunised against meningococcus, pneumococcus, and Hib.

Hyposplenism and functional asplenia can complicate a significant number of illnesses, particularly sickle cell anaemia and coeliac disease. Splenic hypofunction may also occur in rheumatologic diseases (systemic lupus erythematosus [SLE], rheumatoid arthritis), inflammatory bowel disease, graft versus host disease, and nephrotic syndrome.

Hyposplenism is difficult to identify and quantify. There is no defined degree of hyposplenism which indicates an increased risk of sepsis.

For these reasons, the following vaccines are recommended for those with asplenia and those with conditions associated with hyposplenism:- PCV, PPV23, Hib, Men ACWY, MenB and annual influenza vaccines see Tables 3.3 and 3.4.
For those requiring splenectomy, recommended vaccines should be completed at least 2 weeks and preferably 4 weeks or more before surgery. In the case of an emergency splenectomy or if immunisation is overlooked or incomplete pre operatively any recommended vaccines can be commenced 2 weeks post operatively.

**Recommendations**

**Table 3.3.** Additional vaccines for those with functional or anatomical asplenia and hyposplenism

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age at diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;12 months</td>
</tr>
<tr>
<td>MenACWY(^1)</td>
<td>2 doses</td>
</tr>
<tr>
<td></td>
<td>1 month after 6 month vaccines and 2 months after 13 month vaccines</td>
</tr>
<tr>
<td>MenB(^2)</td>
<td>2 doses 1 month apart (2-&lt;6 months of age) or 2 months apart (6-&lt;12 months) and</td>
</tr>
<tr>
<td></td>
<td>booster dose at least 2 months after 2(^{nd}) dose</td>
</tr>
<tr>
<td>PCV(^3)</td>
<td>2 doses</td>
</tr>
<tr>
<td></td>
<td>2 months after 13 month vaccines and at 2 years of age (at least 2 months after previous dose)</td>
</tr>
<tr>
<td>Hib</td>
<td>1 dose</td>
</tr>
<tr>
<td></td>
<td>At 2 years or older</td>
</tr>
<tr>
<td>PPV23</td>
<td>2 doses</td>
</tr>
<tr>
<td></td>
<td>At 2 years or older (2 months after PCV) and 5 years later (if under 65 years of age)</td>
</tr>
<tr>
<td>Inactivated influenza</td>
<td>Annually from 6 months of age (2 doses 1 month apart in the first year of receipt)</td>
</tr>
</tbody>
</table>

\(^1\) Can be given instead of routine MenC at 4 months if not already given

\(^2\) Can be given with routine vaccines but give in different limb

\(^3\) For patients who have already received 1 or more doses of PPV23 defer PCV until at least 1 year after PPV23
All require annual inactivated influenza vaccine from 6 months of age (2 doses 1 month apart in the first year of receipt)

Table 3.4. Schedule of additional vaccines for those with functional or anatomical asplenia and hyposplenism by age at diagnosis

### Table 3.4. Schedule of additional vaccines for those with functional or anatomical asplenia and hyposplenism by age at diagnosis

<table>
<thead>
<tr>
<th>Age &lt; 12 months</th>
<th>Age (months)</th>
<th>Interval from previous vaccine (months)</th>
<th>Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - &lt; 6</td>
<td></td>
<td></td>
<td>MenB</td>
</tr>
<tr>
<td>2 - &lt; 6</td>
<td></td>
<td>1</td>
<td>MenB</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>2</td>
<td>MenB*</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>MenB*</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td>MenACWY + PCV</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td>Hib + PCV</td>
</tr>
<tr>
<td>12-23</td>
<td></td>
<td></td>
<td>MenB</td>
</tr>
</tbody>
</table>

* Omit if 2 doses already given

<table>
<thead>
<tr>
<th>Age 12-23 months</th>
<th>Age (months)</th>
<th>Interval from previous vaccine (months)</th>
<th>Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td></td>
<td>2</td>
<td>MenACWY + PCV</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>1</td>
<td>MenB</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>2</td>
<td>MenB + MenACWY</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td>Hib + PCV</td>
</tr>
<tr>
<td>30-42</td>
<td></td>
<td>12-23</td>
<td>MenB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 2 and older</th>
<th>Interval from previous vaccine (months)</th>
<th>Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hib + PCV</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>MenACWY + MenB</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>PCV (+ MenB if 11 and older)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>MenB (if less than 11 years) + MenACWY</td>
</tr>
</tbody>
</table>

**Chemoprophylaxis**

Recommendations regarding the duration of antibiotic prophylaxis for asplenia and hyposplenia vary. The risk for invasive pneumococcal infection is elevated throughout life but highest for those <16 and > 50 years of age.

At minimum and regardless of immunisation status, antibiotic prophylaxis is recommended for children with asplenia (congenital absence or surgical removal) or sickle cell disease until 5 years of age and for otherwise healthy patients post splenectomy for a minimum of 1 to 2 years post splenectomy.

Although the risk of infection decreases over time, many experts recommend continuing antibiotic prophylaxis throughout childhood and, for those considered at higher risk of infection, for life. High risk patients include poor
Immunisation of Immunocompromised Persons

Clinic attendees, patient with sickle cell disease with surgical splenectomy, splenectomised patient with malignancy, and those with poor antibody response to pneumococcal vaccination. Physicians may elect to use antibiotic prophylaxis in other hyposplenic states.

Antibiotic prophylaxis should only be discontinued if the patient is fully immunized and education and counselling is given regarding the risks of pneumococcal, meningococcal and haemophilus B infection and the need for prompt early management of febrile illness.

Phenoxymethylpenicillin is recommended at the following doses:-
- from 1 month to <6 years 125mg 12 hourly
- 6 years to < 12 years 250mg 12 hourly
- ≥12 years 500mg 12 hourly

Once daily amoxicillin (20mg/kg/dose, max 500mg) can be used as an alternative. For those allergic to penicillin an appropriate macrolide can be used.

**HIV**

People with HIV infection should generally receive all routine (except BCG) and some additional vaccines (see Table 3.5). The timing of immunisation depends on the type of vaccine (live or non-live) and the level of immune suppression. The decision to use live viral vaccines depends on the degree of immunosuppression. For those who are severely immunosuppressed, live viral vaccines should be delayed until immune recovery. BCG is contraindicated regardless of CD4 count.

**Recommendations**

**Children**

Non-live vaccines can be given to all HIV infected children, even those who are significantly immunosuppressed. However, as responses may be blunted, revaccination after recovery of immune function is recommended. If antiretroviral treatment is being initiated, to optimize the vaccine response, delay vaccination until the child has had 6 months of undetectable viraemia and the CD4 count is >15%. The decision to delay vaccination must be balanced against the urgency of attaining protection.

MMR is contraindicated for those who are severely immunosuppressed (see Table 3.5 but can be given when the patient is on specific HIV therapy and the CD4 count is >15%).
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Table 3.5  CD4 counts indicative of severe immunosuppression

<table>
<thead>
<tr>
<th>If aged:</th>
<th>%CD4</th>
<th>CD4 count (x10^6/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 year</td>
<td>&lt;15%</td>
<td>&lt;750</td>
</tr>
<tr>
<td>1-5 yrs</td>
<td>&lt;15%</td>
<td>&lt;500</td>
</tr>
<tr>
<td>≥ 6 yrs</td>
<td>&lt;15%</td>
<td>&lt;200</td>
</tr>
</tbody>
</table>

Varicella vaccine is recommended for susceptible HIV infected children ≥12 months with asymptomatic or mildly symptomatic HIV infection and CD4 count ≥15%. BCG is contraindicated. For specific recommendations see Table 3.6.

Table 3.6. Vaccination Schedule for HIV exposed and infected children

<table>
<thead>
<tr>
<th>HIV exposed but uninfected infants</th>
<th>HIV infected infants &amp; children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>Hep B</td>
</tr>
<tr>
<td>&gt;6 weeks</td>
<td>Hep B</td>
</tr>
<tr>
<td>BCG if 2 HIV PCR tests, one at ≥ 6 weeks of age, are negative</td>
<td><strong>Do not give BCG</strong></td>
</tr>
<tr>
<td>2, 4 and 6 months</td>
<td>Routine schedule</td>
</tr>
<tr>
<td>Routine schedule</td>
<td>Routine schedule (+ MenB)</td>
</tr>
<tr>
<td>Annually (from 6 months of age)</td>
<td>Inactivated influenza vaccine</td>
</tr>
<tr>
<td>7 months</td>
<td>MenACWY</td>
</tr>
<tr>
<td>12 months</td>
<td>PCV</td>
</tr>
<tr>
<td>Hepatitis A vaccine (if HCV or HBV infected)</td>
<td>MMR</td>
</tr>
<tr>
<td></td>
<td>MMR</td>
</tr>
<tr>
<td></td>
<td>MMR</td>
</tr>
<tr>
<td></td>
<td>MMR</td>
</tr>
<tr>
<td></td>
<td>MMR</td>
</tr>
<tr>
<td>13 months</td>
<td>MenC, Hib</td>
</tr>
<tr>
<td>15 months</td>
<td>Varicella (if CD4 count is ≥15%)</td>
</tr>
<tr>
<td></td>
<td>MenACWY</td>
</tr>
<tr>
<td>18 months</td>
<td>Varicella</td>
</tr>
<tr>
<td>24 months</td>
<td>PPV23</td>
</tr>
<tr>
<td>4 – 5 years</td>
<td>DTaP/IPV</td>
</tr>
<tr>
<td>4 – 5 years</td>
<td>MMR</td>
</tr>
<tr>
<td></td>
<td>MMR</td>
</tr>
<tr>
<td></td>
<td>MMR</td>
</tr>
<tr>
<td>12 years</td>
<td>HPV girls (3 doses)</td>
</tr>
<tr>
<td></td>
<td>HPV girls and boys (3 doses)</td>
</tr>
<tr>
<td>11-14 years</td>
<td>Tdap</td>
</tr>
</tbody>
</table>
Chapter 3  Immunisation of Immunocompromised Persons

Adults
More detailed information on the immunisation of HIV infected adults can be found at www.bhiva.org.

Recommendations
• Ensure that the primary DTaP vaccine course has been completed. Give a booster Tdap if none was received within 10 years and repeat Td every 10 years.
• Pneumococcal:
  - For those who have never received PCV13 or PPV23, give a single dose of PCV followed by PPV23 after a minimum interval of 8 weeks.
  - For those who have received 1 or more doses of PPV23, give a single dose of PCV at least 1 year after PPV23.
  - A booster dose of PPV23 can be given at least 5 years after the previous dose (if less than 65 years of age).
• MenACWY, 2 doses. For those who have received Men C, give 1 dose MenACWY after an interval of at least 4 and preferably 8 weeks.
• MenB 2 doses with an interval of at least 8 weeks.
• Inactivated influenza: Give annually.
• Hepatitis A: Give to susceptible patients, 2 dose schedule.
• Hepatitis B: Give to susceptible patients, 3 dose schedule (combined Hepatitis A/ Hepatitis B vaccines may be used).
• HPV: 3 doses schedule at appropriate intervals to male and female patients < 26 years.
• MMR (unless laboratory evidence of immunity or documented prior vaccination).
  - If CD4 count ≥200 cells x 10^6/L:  2 doses (1 month interval).
  - If CD4 count <200 cells x 10^6/L - MMR is contraindicated.
• Varicella for non-immune:
  - If CD4 count ≥400 cells x 10^6/L give 2 doses (1 month interval).
  - If CD4 count ≥200 but <400 x 10^6/L, patients can receive varicella vaccine if stable on antiretroviral therapy.
  - If CD4 count <200 cells x 10^6/L varicella vaccine is contraindicated.
• BCG is contraindicated for all HIV infected persons.

Primary Immunodeficiency
Non-live vaccines are recommended, but may not be efficacious. In general, live vaccines are not recommended for children with primary immune deficiency. However, for some conditions, particularly those with restricted defects, they are safe, efficacious and should be given (Table 3.7). When in doubt, expert advice should be sought.
### Table 3.7. Vaccinations for children with primary immunodeficiency

<table>
<thead>
<tr>
<th>Condition</th>
<th>Routine Non-live Vaccines</th>
<th>Routine Live Vaccines</th>
<th>Additional Vaccines</th>
<th>Contraindicated vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ataxia Telangiectasia</td>
<td>Yes</td>
<td>No</td>
<td>Inactivated influenza, MenACWY, MenB</td>
<td>All live vaccines</td>
</tr>
<tr>
<td>Bruton's agammaglobulinaemia (XLA - X linked agammobulinaemia)¹</td>
<td>Yes</td>
<td>Consider MMR</td>
<td>MenACWY, MenB, Consider varicella</td>
<td>BCG², Live typhoid vaccine, Yellow fever</td>
</tr>
<tr>
<td>Chronic/cyclic neutropoenia</td>
<td>Yes</td>
<td>Yes</td>
<td>Inactivated influenza, MenACWY, MenB</td>
<td>None</td>
</tr>
<tr>
<td>Chronic granulomatous disease (CGD)</td>
<td>Yes</td>
<td>Yes (except BCG)</td>
<td>Inactivated influenza, MenACWY, MenB</td>
<td>BCG², Live typhoid vaccine, Yellow fever</td>
</tr>
<tr>
<td>Chronic mucocutaneous candidiasis (APECED syndrome)</td>
<td>Yes</td>
<td>For some, discuss with relevant specialist</td>
<td>Inactivated influenza, MenACWY, MenB</td>
<td>BCG², Live typhoid vaccine, Yellow fever</td>
</tr>
<tr>
<td>Complement deficiency</td>
<td>Yes</td>
<td>Yes</td>
<td>Inactivated influenza, MenACWY, MenB PPV23 at ≥2 years, at least 2 months post PCV</td>
<td>None</td>
</tr>
<tr>
<td>Common variable immunodeficiency (CVID) &amp; other antibody deficiencies</td>
<td>Yes</td>
<td>For some, discuss with relevant specialist</td>
<td>Inactivated influenza, MenACWY, MenB PPV23 at ≥2 years, at least 2 months post PCV</td>
<td>BCG², Live typhoid vaccine, Yellow fever</td>
</tr>
<tr>
<td>DiGeorge syndrome (22q11 deletion)³</td>
<td>Yes</td>
<td>MMR if CD4 count &gt; 400 x 10⁶/L</td>
<td>Inactivated influenza, MenACWY, MenB</td>
<td>BCG², Live typhoid vaccine, Yellow fever</td>
</tr>
<tr>
<td>Down syndrome</td>
<td>Yes</td>
<td>Yes</td>
<td>Inactivated influenza, MenACWY, MenB PPV23 at ≥2 years, at least 2 months post PCV</td>
<td>None</td>
</tr>
<tr>
<td>Fanconi’s anaemia</td>
<td>Yes</td>
<td>Yes</td>
<td>Inactivated influenza, HPV⁴ from 1 year of age MenACWY, MenB, Varicella</td>
<td>None</td>
</tr>
<tr>
<td>Isolated IgA deficiency¹ IgG subclass deficiency¹</td>
<td>Yes</td>
<td>Yes</td>
<td>Inactivated influenza, Can receive varicella, MenACWY, MenB</td>
<td>Yellow fever</td>
</tr>
<tr>
<td>SCID²</td>
<td>Yes</td>
<td>No</td>
<td>MenACWY, MenB</td>
<td>All live vaccines</td>
</tr>
<tr>
<td>Wiskott Aldrich</td>
<td>Yes</td>
<td>No</td>
<td>Inactivated influenza, MenACWY, MenB</td>
<td>All live vaccines</td>
</tr>
</tbody>
</table>

¹All vaccines are likely to be effective but immune response may be suboptimal
²Often have received BCG prior to diagnosis. Main groups at risk for BCG related complications include SCID, CGD and advanced HIV infection.
³Effectiveness depends on degree of immune suppression. Most children with DiGeorge syndrome have efficient immune systems
⁴As soon as diagnosis is made due to significant increased risk of head, neck, oropharyngeal and anogenital squamous cell carcinoma
⁵Severe combined immunodeficiency syndrome
Immunocompetent household contacts of immunocompromised persons

Optimising vaccination of family members and household contacts (coccooning strategy) may provide indirect protection for those for whom vaccination either does not provide adequate protection or is inappropriate. Optional vaccines to reduce household transmission include annual influenza, pertussis and varicella vaccines (the latter for seronegative persons only).

Siblings of patients with primary immunodeficiency can receive MMR and varicella vaccines. In the event of varicella vaccine associated rash developing, treatment with acyclovir should be initiated to reduce the risk of spread to the immunocompromised persons. With the exception of infants with SCID, rotavirus vaccines can be administered with caution to close contacts of immunocompromised persons.
Chapter 3  Immunisation of Immunocompromised Persons

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