4 Immunisation of special groups

This chapter discusses the special immunisation requirements of individuals at risk of vaccine-preventable diseases due to certain conditions or underlying disease, or through their occupation or other risk factors. The topics covered are:

- pregnancy and lactation (section 4.1)
- infants with special immunisation considerations from birth (section 4.2)
- immunocompromised individuals (section 4.3)
- chronic kidney disease (section 4.4)
- chronic liver disease (section 4.5)
- other special groups (section 4.6)
- immigrants and refugees (section 4.7)
- occupation-related vaccinations (section 4.8)
- travel (section 4.9).

Note: Vaccinators are advised to check the Pharmaceutical Schedule and any online updates (available at **www.pharmac.govt.nz**) for changes to funding decisions for special groups.

4.1 Pregnancy and lactation

4.1.1 Women planning pregnancy

Women who are planning pregnancy should know whether they are immune to measles, rubella and varicella (see sections 11.8.3, 18.5.3 and 21.5.4).

Measles, mumps and rubella vaccine

Two doses of MMR are recommended and funded for eligible women who do not have documented evidence of immunity to measles, mumps and rubella (see section 11.8.3 for evidence). Pregnancy should be avoided for four weeks after vaccination (see section 18.6.1).

Varicella vaccine

Two doses of VV are recommended but not funded for adults who are susceptible to varicella (see section 21.5). VV should not be given to women who are pregnant, and pregnancy should be avoided for four weeks after vaccination (see section 21.5.4).

4.1.2 During pregnancy

Subunit vaccines are considered safe in pregnancy. Live vaccines should not be administered to a pregnant woman because of the theoretical possibility of fetal harm. Seek specialist advice in circumstances where the risk of exposure to an infection outweighs any potential risk of the fetus from immunisation.

Although MMR should not be given to women who are pregnant, in follow-up studies of women who inadvertently received MMR during pregnancy, there was no evidence that MMR is teratogenic or harmful to the mother, her fetus or her newborn.[1] Inadvertent immunisation with a rubella-containing vaccine in early pregnancy is no longer considered an indication for termination of pregnancy.[1] See the relevant disease chapters, particularly measles (section 11.8.2), rubella (section 18.8.3) and varicella (section 21.8.6), for recommendations on managing exposure to diseases during pregnancy.

Influenza vaccine

The quadrivalent influenza vaccine is recommended and funded for pregnant women and should be offered to women at any stage of pregnancy, as soon as the annual influenza vaccine becomes available (see section 10.5). Both the pregnant woman and her fetus are at increased risk of influenza complications;[2, 3] influenza vaccination is therefore recommended during pregnancy to reduce this risk.[4]

Maternal influenza vaccination also offers protection to the neonate through maternal antibody transfer.[3, 4] Influenza vaccines are not registered for infants aged under 6 months; therefore vaccination during pregnancy helps protect newborns and infants who are too young to be vaccinated.[2, 3] Maternal influenza vaccination is significantly associated with reduced risk of influenza virus infection[5] and hospitalisation for an influenza-like illness in infants up to 6 months of age.[3, 5]

There is no evidence that influenza vaccine prepared from a virus subunit causes harm to the fetus or neonate.[6, 7, 8]

Pertussis vaccine (Tdap)

Pertussis is a severe infection in infants too young to have been fully immunised. The tetanus, diphtheria and pertussis vaccine (Tdap) is recommended and funded to be given from 16 weeks' gestation in every pregnancy, preferably in the second trimester, to protect both the mother and her infant from pertussis (see section 14.5).[9, 10, 11] Postpartum maternal Tdap vaccination can reduce the risk of a mother infecting her baby but does not have the added benefit of providing passive antibodies.

See section 14.5 for information about maternal pertussis vaccine effectiveness and safety.

Close contacts

Confirmation of pregnancy should act as a trigger to review the pertussis vaccination status of all the pregnant woman's close contacts. This includes making sure siblings have received the usual Schedule vaccines and offering Tdap to adults, although this is only currently funded for certain special groups.

4.1.3 Breastfeeding and post-partum

> All vaccines on the National Immunisation Schedule and those recommended for special groups are safe for breastfeeding women.

Measles, mumps and rubella vaccine

Up to two doses of MMR are recommended and funded **after delivery** for eligible women who do not have documented evidence of immunity to measles, mumps and rubella. Breastfeeding is not a contraindication to MMR (see section 11.8.3).

Pertussis vaccine (Tdap)

A single dose of Tdap is funded for parents or primary caregivers of infants admitted to a neonatal intensive care unit or special care baby unit for more than three days and whose mothers had not received Tdap at least 14 days prior to birth.

A single dose of Tdap is also recommended but not funded for all new mothers who did not receive a Tdap vaccination during pregnancy.

Varicella vaccine

VV is recommended but not funded for all susceptible adults. Pregnant women who are non-immune can be offered VV **after delivery**.

If the mother is susceptible to varicella, VV for the mother is recommended and funded after delivery if the baby or other household members are immunocompromised (see section 21.5).

4.2 Infants with special immunisation considerations from birth

Further details are given in section 4.3 for infants born with primary immunodeficiency, including Down syndrome (section 4.3.3), secondary immunodeficiency (section 4.3.4), functional asplenia (section 4.3.11) and HIV (section 4.3.12).

4.2.1 Infants born to mothers with positive or unknown hepatitis B (HBsAg) status

Infants born to mothers who are known to be HBsAg-positive require hepatitis B vaccine (HepB) plus hepatitis B immunoglobulin (HBIG) to be given at or as soon as possible after birth; to continue vaccination as per the Schedule at 6 weeks, 3 and 5 months; and to undergo serological testing for hepatitis B antigen and antibodies (HBsAg and anti-HBs) at 9 months of age.

Infants of mothers whose HBsAg status is unknown at the time of delivery require HepB at birth while waiting for the results of urgent HBsAg testing on the mother (see section 8.5.2). If mother is found to be HBsAg positive, HBIG will also be required.

4.2.2 Preterm and/or low birthweight infants

Vaccination as per the Schedule (ie, at the usual chronological age, with the usual vaccine dosage and interval) is recommended for preterm and/or low birthweight infants. There is a potential risk of apnoea in preterm infants with respiratory immaturity. Apnoea monitoring should be considered after the first vaccination event.[10] For infants who experience apnoea after their first vaccination event, apnoea monitoring should be considered for 48–72 hours after subsequent vaccination events, but avoiding or delaying vaccination is not recommended.[12]

Hepatitis B vaccine

All preterm and low birthweight infants born to HBsAg-positive mothers should be managed the same way as term infants and receive HepB and HBIG to be given at or as soon as possible after birth (see section 8.5.2). These infants should continue vaccination as per the usual Schedule, starting at age 6 weeks.

Rotavirus vaccine

If an infant is in hospital at 6 weeks old, the Schedule vaccines, including rotavirus vaccine, should be given in hospital. Standard infection control precautions should be maintained. Administration of rotavirus vaccine to medically stable, hospitalised infants at 6 weeks of age has been shown to be well-tolerated. No increase in nosocomial rotavirus transmission has been observed within neonatal intensive care units.[13, 14, 15] Rotavirus vaccine can be given to preterm infants who are receiving corticosteroids. For immunocompromised infants or mothers, also see section 4.3.3 and section 4.3.6.

Pneumococcal vaccines

Infants born before 28 weeks' gestation are eligible for pneumococcal vaccination as part of an extended immunisation programme for high risk groups (see section 15.5.2).

Infants born at 28 weeks' gestation or later, who do not have a condition eligible for extended pneumococcal immunisation, should receive PCV10 (Synflorix) as per the Schedule at ages 6 weeks, 5 months and 12 months.

Influenza vaccine

Preterm and/or low birth weight infants with an eligible condition are recommended to receive an annual funded influenza vaccination from 6 months of age (see Table 10.2).

Influenza vaccination is recommended (but not funded) for close contacts of preterm infants, including children from age 6 months (see section 10.5.4).

Pertussis vaccine (Tdap)

It is essential that siblings of preterm infants are up to date with Schedule vaccinations, to reduce the risk of pertussis transmission to the infant (see section 14.5). Adolescents should have received Tdap in year 7 or at age 11 years as part of the Schedule. Pertussis-containing vaccine is funded for primary and catch-up vaccination of all children aged under 18 years (see Appendix 2 for catch-up schedules).

A single dose of Tdap is recommended and funded for parents or primary caregivers of infants admitted to a neonatal intensive care unit or special care baby unit for more than three days and whose mother did not receive maternal Tdap vaccination at least 14 days before the baby's birth.

Regardless of maternal vaccination history, it is recommended that all caregivers of infants born at less than 32 weeks' gestation receive a single dose of Tdap (not funded). This is because by 28–32 weeks' gestation the level of transplacental maternal antibodies in the infant is only half of the maternal circulating level, compared with higher than maternal levels by term.[9, 16, 17]

4.2.3 Infants with congenital heart disease

Congenital heart disease (CHD) may occur alone (eg, a single ventricle defect or shunt dependent lesion), or with other congenital defects (eg, immunodeficiency, endocrine dysfunction and facial abnormalities in DiGeorge syndrome or asplenia in heterotaxy syndrome).

Vaccination of infants with congenital heart disease

Infants with CHD and who are immunocompetent can receive vaccination as per the Schedule including rotavirus and varicella vaccines. For infants with CHD who were also born preterm or with a low birthweight, see also section 4.2.2.

Infants with a complex single ventricle defect or shunt dependent lesion who have undergone the Norwood procedure may have an increased risk of systemic decompensation. There is limited evidence linking the onset of decompensation to vaccination. As a precautionary measure, these infants may require hospital admission for observation or close parental monitoring at home for 48–72 hours after vaccination events. Discuss monitoring requirements with the infant's specialist prior to vaccination.[18]

Timing of vaccination may be affected when cardiac surgery is scheduled to avoid adding extra stress on these infants during this time. Vaccines should be administered at least one week before planned cardiac surgery. After cardiac surgery, administration of subunit vaccines should be delayed by 4–6 weeks for those at risk of systemic decompensation (eg, after a Norwood procedure).

For further information see Starship guidelines available from **https://www.starship.org.nz/guidelines/immunisations-and-cardiac-infants/**

Live vaccines – caution

If an infant has received blood products (eg, bypass or blood transfusion during surgery), delay administration of live vaccine is until seven months post-surgery.[18] This does not apply to administration of rotavirus vaccine.

See Table A6.1 in Appendix 6 for suggested intervals between administration of blood products and MMR or VV.

If no blood products have been given, the usual 4–6 weeks post-operative interval is recommended for those at risk of systemic decompensation, as above.

Some cardiac defects can be associated with immune deficiency, eg Di George syndrome. Most such patients can safely be given live viral vaccines when due – after assessment of immune function (see section 4.3.3). Seek specialist advice.

Pneumococcal vaccine

Children who have cardiac disease with cyanosis or failure, chronic pulmonary disease, Down syndrome, functional asplenia, immunodeficiency, or renal failure are eligible for extended pneumococcal immunisations as high-risk groups (see section 15.5.2).

Influenza vaccine

Infants and children with CHD, with or without cyanosis or failure, and children on long-term aspirin are eligible to receive funded annual influenza vaccination from 6 months of age (see Table 10.2).

Influenza vaccination is recommended (but not funded) for close contacts of infants and children with CHD, including children (see section 10.5.4).

Pertussis vaccination

It is essential that siblings and other close household contacts of infants with CHD are up to date with Schedule vaccinations, to reduce the risk of pertussis transmission to the infant (see section 14.5). Ensure catch-up vaccination of all children aged under 18 years (see Appendix 2 for catch-up schedules).

Varicella vaccine

Children on long-term aspirin can receive varicella vaccination as per the Schedule. There has been no reported association between varicella vaccination and the onset of Reye's syndrome in children on long-term aspirin to prevent thrombosis. The use of aspirin during natural chickenpox infection has been associated with Reye's syndrome.[18]

4.2.4 Infants with immunocompromise, including primary immunodeficiencies from birth

Seek guidance on immunisation of infants with severe primary immunodeficiencies (see section 4.3.3). Often these infants are unable to mount adequate responses to vaccines. Note: Rotavirus vaccine is contraindicated in any infant with possible severe combined immune deficiencies (SCID) due to the risk of chronic diarrhoea and prolonged viral shedding.[19, 20]

Some infants with congenital liver or kidney conditions are likely to need transplantation. An accelerated immunisation schedule for these infants in provided in Table 4.3. Extra immunisations may be warranted for other chronic kidney and chronic liver conditions (see sections 4.4 and 4.5). Infants with biliary atresia may have polysplenia (functional hyposplenia; see section 4.3.11).

Infants of mothers who have received biologic immunosuppressant therapy during pregnancy also may have a reduced response to the primary series vaccinations (section 4.3.6).

4.3 Immunocompromised individuals

The nature and degree of immunocompromise determines an individual's immune response and which vaccines are recommended and can be safely administered. Individuals who are immunodeficient or immunosuppressed due to a disease and/or treatment may have an increased risk from infectious diseases. These individuals should be vaccinated as a matter of priority.

Children aged under 18 years, and adults aged 18 years or older who are eligible to receive publicly funded health and disability services in New Zealand, are eligible to receive the usual Schedule vaccines and additional funded vaccines when they meet the eligibility criteria for special groups.

Vaccinators are advised to regularly check the Pharmaceutical Schedule and any online updates (**www.pharmac.govt.nz**) for changes to funding decisions for special groups.

> It is important to ensure that the household contacts of these individuals are immune to vaccine-preventable diseases whenever possible.

The following definitions are used in this *Handbook*:

- **Immunocompetent** – a broad term referring to normal immune system function.
- **Immunocompromise** – a broad term referring to altered immune system function. The individual's ability to mount an immune response may be reduced or increased because of a disease, treatment or genetic disorder.
- **Immunomodulation** – changes in immune system function in response to medication, cancer chemotherapy or immunotherapy treatments.
- **Immunostimulant** – a substance able to stimulate or increase an immune response.
- **Immunosuppression** – a reduced ability to mount an immune response caused by medication, cancer chemotherapy or immunotherapy treatment.
- **Immunodeficiency** – a reduced ability to mount an immune response and fight off infection. Immunodeficiency conditions are classified as primary and secondary, dependent on the cause.

4.3.1 Vaccination of close contacts of immunocompromised individuals

Immunocompetent siblings, household and other close contacts of immunocompromised individuals are recommended to receive all the Schedule vaccines at the recommended ages.

All Schedule vaccines can be given to close contacts of immunocompromised individuals. It is important to ensure that close contacts are immune for the added protection of the immunocompromised individual. If indicated by the usual BCG eligibility criteria (see section 20.5.2), it is safe to give BCG vaccine to infants of immunocompromised household contacts.

Rotavirus vaccine

Rotavirus vaccine can be given to infants who are in close contact with an immunocompromised individual. The evidence shows that transmission of the rotavirus vaccine virus to contacts is low, and no cases were symptomatic.[13, 14, 15]

Measles, mumps and rubella vaccine

MMR can be given to children and eligible adults who are in close contact with an immunocompromised individual. MMR vaccine viruses are considered non-transmissible; there is no evidence of the current MMR vaccine viruses being transmitted from vaccine recipient to a close contact.[21, 22] See section 11.5 for information about eligibility and the recommended MMR vaccination schedule.

Varicella vaccine and zoster vaccine

Age-appropriate varicella (VV) or zoster (ZV) vaccine can be given to close contacts of an immunocompromised individual. Transfer of vaccine virus to an immunocompromised person is rare and only possible if the vaccinated person develops a varicella- or zoster-like rash. In this situation, the rash should be covered and close contact with the person who is immunocompromised avoided for the duration of the rash.[23] (See sections 21.5 and 22.5 for eligibility.)

Influenza vaccine

Annual influenza vaccination is recommended but not funded for all children aged 6 months or older and adults, particularly those who are close contacts of an immunocompromised individual.

4.3.2 Immune checkpoint inhibitor (immunostimulant) therapy

> Specialist advice must be sought before administering any vaccine to individuals who are currently being treated with immune checkpoint inhibitors or have discontinued treatment within the past six months.
>
> A cautious approach to vaccination is recommended when balancing an individual's risk of developing an immune-related adverse event, their potential risks of disease and the potential benefits of vaccination during, and for 6 months after, treatment with immune checkpoint inhibitors.

There are four immune checkpoint inhibitor medications currently available in New Zealand. Nivolumab (Opdivo) and pembrolizumab (Keytruda) target PD-1 protein, atezolizumab (Tecentriq) targets PD-L1 protein, and ipilimumab (Yervoy) targets CTLA-4 protein.

Target proteins (checkpoints) on healthy cells help the immune system distinguish 'self' from 'non-self' and prevent the immune system from attacking 'self'. Some tumour cells develop these checkpoints so they will not be seen as 'altered self' by the immune system and attacked. Immune checkpoint inhibitor therapy uses specially designed monoclonal antibodies to block the checkpoints on both healthy cells and tumour cells, allowing the tumour cells to be recognised as 'altered self' and attacked by the immune system.[24]

The stimulated immune system may also no longer distinguish healthy cells.[24] Immune-related adverse events (irAEs) associated with immune checkpoint inhibitor treatment, including rhabdomyolysis and encephalopathy, Guillain-Barré syndrome, myopathy, nephritis, fatal myositis, myocarditis, and other autoimmune conditions, are well-documented.[25, 26]

There is a theoretical risk that an immune response to vaccination could trigger the onset of an irAE.[27] There is limited published safety data on the use of vaccines (live or subunit) in individuals being treated with one or more immune checkpoint inhibitors. Study numbers are still small, and there are conflicting study outcomes (eg, an increase in irAEs[27] and no increase in irAEs[28] following influenza vaccination). There are currently no international consensus statements on the use of vaccines in individuals being treated with immune checkpoint inhibitors.

4.3.3 Primary immunodeficiency

Primary immunodeficiencies that present in childhood are usually caused by an inherited genetic disorder. They can result in defects in antibody production (B-lymphocyte disorders), defects in the development of cell-mediated immunity (T-lymphocyte disorders), combination defects (disorders or syndromes affecting B- and T-lymphocytes) and defects of complement and phagocytic function.[29]

Children with Down syndrome are at increased risk from respiratory and severe infections due to multiple immune deficits in both the innate and adaptive immune systems, as well as anatomical structural differences,[30, 31] and should be considered as primary immune deficiency.

Vaccines for individuals with a primary immunodeficiency

Live vaccines – caution

Diagnosis of primary immunodeficiency is often not made before children start their Schedule vaccinations. For infants who have the potential to be immunodeficient (eg, have a familial history of inherited immunodeficiency, administration of live vaccines such as BCG, rotavirus vaccine, MMR, and/or varicella vaccines may be contraindicated or need to be deferred until the infant is identified as being immunocompetent.

Live vaccines are contraindicated for all individuals with T lymphocyte-mediated immunodeficiency or a combined B- and T-lymphocyte deficiency. Most of these individuals will be on intravenous immunoglobulin (IVIG) replacement therapy, which provides passive protection against most vaccine-preventable infections.

Influenza vaccine

Influenza vaccine is funded for all individuals with primary immunodeficiency, including Down syndrome, aged 6 months or older. Regardless of their age, all immunodeficient individuals who receive influenza vaccine for the first time are recommended to receive two vaccine doses at least four weeks apart (second dose unfunded), and one funded dose annually after that. A second dose is funded for children aged 6 months to under 9 years when influenza vaccine is being used for the first time.

Pneumococcal vaccines

Infants and children aged under 5 years

Children in this age group with a diagnosed primary immunodeficiency or Down syndrome are eligible to receive extended pneumococcal immunisation for high-risk groups (see section 15.5.2).

A course of PCV13 vaccine at 6 weeks and 3, 5 and 12 months replaces doses of PCV10 vaccine on the usual Schedule (see sections 15.5.2 and 15.5.3) followed by age-appropriate 23PPV vaccinations.

Children aged 5 years or older and adults

Children age 5 years or older and adults with a diagnosed primary immunodeficiency or inherited complement deficiency are eligible to receive one PCV13 followed by age-appropriate 23PPV vaccinations (see section 15.5.2).

Children with Down syndrome aged 5 years to under 18 years

Children in this age group who **have** received at least two doses of PCV10 and have Down syndrome are recommended and funded to receive one PCV13 followed by up to two doses of 23PPV (see section 15.5.2).

Children in this age group who **have not** received at least two doses of PCV10 and have Down syndrome are recommended and funded to receive up to two doses of 23PPV (see section 15.5.2).

Meningococcal conjugate vaccines

The current funded meningococcal vaccines are group C and group ACWY meningococcal conjugate vaccines: MenC (NeisVac-C) and MenACWY-D (Menactra).

There is a possibility of blunting of some PCV serotype antibody responses when MenACWY-D (Menactra) is given concurrently with PCV13 because both vaccines contain diphtheria-derived proteins as conjugate. The clinical significance of this blunting, observed in a clinical trial with PCV7,[32] is unknown and the affected serotypes (4, 6B, 18C) are currently rare in New Zealand. The benefits of achieving broad meningococcal protection as early as possible in immunocompromised infants outweigh the theoretical risk of modest reduction of some pneumococcal antibody levels, such that, MenACWY-D is recommended at age 9 months (see Table 4.4 and Table 4.5) rather than waiting until after completion of the PCV13 series. Note: two doses of MenACWY-D given at least three months apart are recommended as a primary series: each dose should be given more than four weeks after PCV13, if possible, to reduce this risk of interference.

Infants aged under 9 months

Infants aged under 9 months who have an inherited complement deficiency are recommended and funded to receive two doses of MenC given a minimum of eight weeks apart. For broader meningococcal group coverage in infants aged 6 weeks to 9 months, MenACWY-T (Nimenrix) is also available but not funded (see section 12.5).

Infants and children aged 9–23 months

Infants and children aged 9–23 months who are diagnosed with an inherited complement deficiency are recommended and funded to receive two doses of MenACWY-D at least three months apart, followed by a booster dose after three years then five-yearly. MenACWY-D is recommended to be given at least four weeks after PCV13.

Children aged 2 years to under 8 years

Children aged 2 years to under 8 years who are diagnosed with an inherited complement deficiency are recommended and funded to receive two doses of MenACWY-D at least eight weeks apart, followed by a booster dose after three years then five-yearly.

Children aged 9 years or older and adults

Children aged 9 years or older and adults who are diagnosed with an inherited complement deficiency are recommended and funded to receive two doses of MenACWY-D at least eight weeks apart, followed by a booster dose every five years.

Group B meningococcal recombinant vaccine (4CMenB)

Vaccination with 4CMenB, to protect against disease caused by the group B meningococcal serotype, is recommended (but not funded) for infants, children and adults with an inherited complement deficiency and an increased risk of meningococcal disease.

Vaccines used to test for a primary immunodeficiency

Hib-PRP, 23PPV and Tdap vaccines may be used in testing for a primary immunodeficiency, on the recommendation of an internal medicine physician or paediatrician. Hib-PRP and Tdap vaccines are funded for primary immunodeficiency testing in children aged under 18 years and eligible adults.

Vaccination advice, by primary immunodeficiency

Below is a summary of the vaccination recommendations for individuals with a primary immunodeficiency.[29] (See also Table A6.1 in Appendix 6.)

Live vaccines are contraindicated for all individuals with T lymphocyte-mediated immunodeficiency or a combined B- and T-lymphocyte deficiency. Most of these individuals will be on IVIG replacement therapy, which provides passive protection against most vaccine-preventable infections.

B lymphocyte deficiencies (humoral)

X-linked agammaglobulinaemia and common variable immune deficiency

- BCG vaccine is contraindicated.
- Only administer live-virus vaccines (rotavirus, MMR, VV, ZV) after discussion with the individual's specialist.
- The efficacy of any vaccine that is dependent on a humoral response, such as 23PPV, is doubtful.
- During IVIG therapy, only influenza vaccination is recommended.

Selective IgA deficiency, IgG subclass deficiency and hypogammaglobulinaemia

- BCG vaccine may be contraindicated.

- Live-virus vaccines (rotavirus, MMR, VV, ZV) can be administered.
- All vaccines are probably effective.
- Influenza vaccine is recommended.

Combined lymphocyte deficiencies (T and B cell)

Complete defects (eg, SCID or athymia)

- All live vaccines are contraindicated.
- All other vaccines are likely to be ineffective prior to immune reconstitution, and passive protection must be optimised.

Partial defects (eg, most patients with DiGeorge syndrome, Wiskott Aldrich syndrome, ataxia telangiectasia)

- Provision of selected live vaccines is dependent on specialist advice after assessment of degree of immune compromise.
- Hib, pneumococcal (PCV13 and 23PPV), and meningococcal vaccines are recommended, except when the individual receives IVIG therapy.
- Non-live vaccines should be provided as per the usual Schedule, except when the individual receives IVIG therapy.
- Influenza vaccination is recommended, including individuals who receive IVIG therapy.

Complement deficiencies

Deficiency of C1–9, mannose-binding lectin, properdin, factor B

- There are no specific contraindications or precautions.
- The usual Schedule vaccines are probably effective.
- Influenza, Hib, pneumococcal (PCV13 and 23PPV) and meningococcal vaccines are recommended.

Phagocytic function deficiencies

Chronic granulomatous disease and cyclic neutropenia

- BCG and live vaccines (bacterial and viral) are contraindicated.
- Live-virus vaccines (rotavirus, MMR, VV, ZV) can be administered.
- The usual Schedule vaccines are probably effective.
- Influenza vaccine is recommended.

Leukocyte adhesion defect, myeloperoxidase deficiency

- All live vaccines are contraindicated.
- Influenza, Hib, pneumococcal (PCV13 and 23PPV) and meningococcal vaccines are recommended.

4.3.4 Secondary (acquired) immunodeficiency

Secondary immunodeficiencies are acquired. They occur in individuals with HIV, individuals with malignant neoplasms, solid-organ transplant recipients, and in individuals receiving cancer chemotherapy or other immunotherapies.[29]

The ability of individuals with a secondary immunodeficiency to develop an adequate immunological response depends on the disease and/or the type and intensity of immunosuppressive therapy. After immunosuppressive therapy is discontinued, immune recovery can take weeks to years. Ideally, vaccination should be conducted prior to any planned immunosuppression.

Vaccines for individuals with acquired immunodeficiency

In diseases such as HIV or chronic renal failure, where immune impairment is likely to be progressive, ensuring the individual is up to date with Schedule and additional funded vaccines earlier in their disease process may result in better antibody responses.

Before commencing a therapy that would be expected to cause significant immunosuppression, a full vaccination history should be obtained. Then, if circumstances permit, such as prior to commencing immunosuppressive therapy for rheumatological disease or prior to solid organ transplant, vaccination should be completed following the usual Schedule (including HPV from age 9 years). Administration of additional funded vaccines (eg, varicella for children, zoster for certain adults, meningococcal or pneumococcal vaccines) may be appropriate. However, when immediate commencement of therapy is clinically indicated, it is not recommended to delay therapy to allow for vaccination.

Live vaccines – caution

Live vaccines (BCG, rotavirus, MMR and VV) are contraindicated for individuals who are immunosuppressed because of the risk of disseminated vaccine disease.

Individuals who are not considered to be significantly immunodeficient or immunosuppressed can receive live vaccines. For individuals who are due to commence elective immunosuppressive therapy, live vaccines (MMR, VV, ZV) should be administered at least four weeks prior to commencement of therapy. Live vaccines should also be administered at least four weeks before a predicted transplant.

On a case-by-case basis with appropriate follow-up in place, a specialist may recommend that VV is administered less than four weeks before a predicted transplant or to a post-transplantation paediatric patient.[33]

See sections 11.5, 21.5 and 22.5 for information about the recommended MMR, VV and ZV vaccination schedules and eligibility criteria.

Influenza vaccine

Influenza vaccine is funded for all immunodeficient and immunosuppressed individuals aged 6 months or older. Regardless of their age, all immunocompromised individuals who receive influenza vaccine for the first time are recommended to receive two vaccine doses at least four weeks apart (second dose unfunded), and one funded dose annually after that. A second dose is funded for children aged 6 months to under 9 years when influenza vaccine is being used for the first time.

Haemophilus influenzae type b (Hib-PRP) vaccines

Infants and children aged under 5 years

Vaccination against Hib disease for infants and children aged under 5 years is included in the usual Schedule. DTaP-IPV-HepB/Hib vaccine is recommended at 6 weeks, 3 months and 5 months of age followed by a booster dose of Hib-PRP vaccine) at age 15 months.

Children aged 5 years or older and adults

Children aged 5 years or older and adults who have functional asplenia, or are pre-/post-solid organ transplantation, pre-/post-splenectomy, post-chemotherapy, receiving immunosuppressive therapy for longer than 28 days, or on renal dialysis, are recommended and funded to receive one dose of monovalent Hib-PRP vaccine.

Children and adults post-haematopoietic stem cell transplantation

A three-dose series of Hib-PRP is recommended for children and adults who are post-haematopoietic stem cell transplantation. Children aged under 10 years who are revaccinated using DTaP-IPV-HepB/Hib will receive three doses of Hib-PRP-containing vaccine.

For children aged 10 years or older and adults who receive monovalent Hib-PRP, one dose is funded, and the immunisation benefit can be claimed for vaccine administration. Doses two and three are not funded. Hib-PRP can only be ordered from ProPharma and an immunisation benefit cannot be claimed for vaccine administration.

Pneumococcal vaccines

Infants and children aged under 5 years

Children in this age group who have functional asplenia, HIV, nephrotic syndrome or renal failure, or are pre-/post-solid organ transplantation, pre-/post-splenectomy, post-haematopoietic stem cell transplantation, or have been receiving high-dose corticosteroid therapy for more than two weeks, other immunosuppressive therapy for longer than 28 days, or radiotherapy are recommended and funded to receive pneumococcal vaccination as part of the extended immunisation programme for high risk groups (see section 15.5.2).

Administration of PCV13 vaccine at 6 weeks, 3, 5 and 12 months replaces PCV10 vaccine on the Schedule (see sections 15.5.2 and 15.5.3) once the eligible condition has been identified followed by age-appropriate 23PPV vaccinations.

Children aged 5 years to under 18 years

Children in this age group who have a condition listed in the *Infants and children aged under 5 years* section above are recommended and funded to receive one PCV13 followed by up to two doses of 23PPV (see section 15.5.2).

Children aged 5 years or older and adults

Children in this age group and adults who have an acquired complement deficiency, functional asplenia or HIV, or are pre-/post-solid organ transplantation, pre-/post-splenectomy, post-chemotherapy, post-haematopoietic stem cell transplantation, or on renal dialysis, are recommended and funded to receive one PCV13 followed by age-appropriate 23PPV vaccinations (see section 15.5.2).

It is recommended that individuals in this age group who will be or have been receiving high-dose corticosteroid therapy for more than two weeks or other immunosuppressive therapy for longer than 28 days receive pneumococcal vaccination (this is not funded).

Meningococcal conjugate vaccines

The current funded meningococcal vaccines are group C and group ACWY meningococcal conjugate vaccines: MenC (NeisVac-C) and MenACWY-D (Menactra).

See *Meningococcal conjugate vaccines* in section 4.3.3 for an explanation of the timing of MenACWY-D and PCV13 in children.

Infants aged under 9 months

Infants aged under 9 months who have an acquired complement deficiency, functional asplenia or HIV, or are pre-/post-splenectomy, pre-/post-solid organ transplantation, or post-haematopoietic stem cell transplantation, or pre/post immunosuppressive therapy for longer than 28 days are recommended and funded to receive two doses of MenC a minimum of eight weeks apart.

For broader meningococcal group coverage in infants aged 6 weeks to 9 months, MenACWY-T (Nimenrix) is also available but not funded (see section 12.5).

Infants and children aged 9–23 months

Infants and children in this age group who have an acquired complement deficiency, functional asplenia or HIV, or are pre-/post-splenectomy or pre-/post-solid organ transplantation, are recommended and funded to receive two doses of MenACWY-D at least three months apart, followed by a booster dose after three years then five-yearly.

Infants and children in this age group who are post-haematopoietic stem cell transplantation or will be or have been receiving immunosuppressive therapy for longer than 28 days are recommended and funded to receive two doses of MenACWY-D at least three months apart. Booster doses of MenACWY-D after three years and then five-yearly are recommended (although not funded) if immunosuppression is long-term.

Children aged 2 years to under 8 years

Children in this age group who have an acquired complement deficiency, functional asplenia, HIV, or are pre-/post-splenectomy or pre-/post-solid organ transplantation, are recommended and funded to receive two doses of MenACWY-D at least eight weeks apart, followed by a booster dose after three years then five-yearly.

Children in this age group who are post-haematopoietic stem cell transplantation or receiving immunosuppressive therapy for longer than 28 days are recommended and funded to receive two doses of MenACWY-D at least eight weeks apart. If immunosuppression is long-term, booster doses of MenACWY-D after three years and then five-yearly are recommended (although not funded).

Children aged 9 years or older and adults

Children in this age group and adults who have an acquired complement deficiency, functional asplenia, HIV, or are pre-/post-splenectomy or pre-/post-solid organ transplantation, are recommended and funded to receive two doses of MenACWY-D at least eight weeks apart, followed by a booster dose every five years.

Children in this age group and adults who are post-haematopoietic stem cell transplantation or will be or have been receiving immunosuppressive therapy for longer than 28 days are recommended and funded to receive two doses of MenACWY-D at least eight weeks apart. If immunosuppression is long-term, a booster dose of MenACWY-D is recommended (but not funded) every five years.

Group B meningococcal vaccine (4CMenB)

Vaccination with 4CMenB (Bexsero), to protect against disease caused by the group B meningococcal serotype, is recommended (but not funded) for infants, children and adults who have an acquired complement deficiency, functional asplenia or HIV, or are pre-/post-splenectomy or pre-/post-solid organ transplantation, or post-haematopoietic stem cell transplantation, or prior to planned or following immunosuppressive therapy for longer than 28 days. See Table 12.4 for the recommended schedule.

Measles or chickenpox exposure post-transplantation

Specialist advice should be sought if an individual who is immunosuppressed is a suspected or confirmed contact of a measles or chickenpox case. Post-transplantation, the use of passive immunisation with IG after exposure to measles or chickenpox should be based on the documentation of negative antibody titres, or where immune status is unknown. See *Human normal immunoglobulin prophylaxis for contacts* and *Prophylaxis with intravenous immunoglobulin* in section 11.8.2 and *Post-exposure prophylaxis with zoster immunoglobulin* in section 21.8.2.

4.3.5 Individuals receiving corticosteroids

Corticosteroids reduce inflammation and generally suppress the immune system. The minimum amount of corticosteroid administration sufficient to cause immunosuppression is not well defined, and is dependent on the treatment used, dose, route of administration and duration. A daily dosage equivalent to 2 mg/kg oral prednisone or greater, or a total daily dosage of 20 mg or greater, particularly when given for 14 days or more, is considered sufficient to raise concern about the safety of live vaccines. Individuals receiving fludrocortisone or long-term dexamethasone should not receive live vaccines during treatment and for three months after discontinuation.

A single dose of dexamethasone for management of an acute respiratory illness in children is not associated with a decrease in endogenous corticosteroid levels[34] or immunosuppression. No minimum interval is required between administration of a single dose of dexamethasone and a live vaccine, as long the individual is not acutely unwell.

Rotavirus vaccine can be given to preterm infants born who are receiving corticosteroids.

Live vaccines *can be* administered to individuals who:

- are using topical corticosteroid therapy, including on the skin or respiratory tract (by aerosol), or receiving local intra-articular, bursal or tendon corticosteroid injections because such therapies do not usually result in immunosuppression
- are receiving maintenance *physiological* doses of corticosteroids
- are receiving oral budesonide or fluticasone to treat an inflammatory bowel condition
- received a single dose of dexamethasone for management of an acute respiratory illness
- are receiving low to moderate doses of systemic steroids given daily or on alternate days
- are receiving high-dose corticosteroids for fewer than 14 days.

Live vaccines *should not* be administered to individuals:

- receiving high dose corticosteroids daily or on alternate days for more than 14 days
- receiving long-term dexamethasone or hydrocortisone that is not for physiological maintenance or fludrocortisone
- who have a disease process that causes immunosuppression, except in special circumstances after discussion with the individual's specialist.

See Table 4.1 for guidelines according to each corticosteroid agent.

Table 4.1: Guidelines for live vaccine administration for individuals receiving corticosteroid agents

Corticosteroid agent	Dose regime		Administration of live vaccines
Topical or local corticosteroid doses	Any agent, any dose • applied to the skin • inhaled • injected locally into a joint, bursa or tendon		Any time before, during or after treatment
Budesonide	Oral or inhaled, any dose		Any time before, during or after treatment
Dexamethasone	Single dose for an acute respiratory illness		Any time before or after dose
	Physiological maintenance doses		Any time before, during or after treatment
	Long-term treatment not for physiological maintenance		Delay for 3 months after discontinuation
Fludrocortisone	Any dose		Delay for 3 months after discontinuation
Fluticasone	Oral or inhaled, any dose		Any time before, during or after treatment
Hydrocortisone	Physiological maintenance doses		Any time before, during or after dose
	Long-term treatment not for physiological maintenance		Delay for 3 months after discontinuation
Prednisone / Prednisolone[35]	*Infants and children <10kg*	*Children and adults ≥10kg*	
	<2mg/kg per day, any duration	<20mg per day, any duration	Any time before, during or after treatment
	≥2mg/kg per day for <14 days	≥20mg per day for <14 days	Immediately on discontinuation
	≥2mg/kg per day for ≥14 days	≥20 mg per day for ≥14 days	Delay for 1 month after discontinuation

Note: The guidelines in this table are intended to ensure safety of administration of the live vaccines to individuals receiving corticosteroids; optimal vaccine immunogenicity may not be achieved.

4.3.6 Individuals receiving non-corticosteroid immunomodulatory agents

Non-biologic agents

Hydroxychloroquine, mesalazine/5-ASA, olsalazine and sulfasalazine act on the immune system and reduce the inflammatory responses associated with immune-mediated inflammatory disease (IMID, also known as autoimmune diseases) but do not cause immunosuppression.[36]

Azathioprine, 6-mercaptopurine, methotrexate, cyclophosphamide, cyclosporine, leflunomide, mycophenolate mofetil and tacrolimus suppress immune system function to varying degrees, dependent on the agent and intensity of therapy, to reduce symptoms and tissue damage associated with IMID or prevent rejection of a transplanted organ.[36]

Biologic agents

Immunotherapeutic treatment of disease has increased rapidly over recent years. The treatment relies on administration of biologic agents that selectively target components of the immune system (eg, antibodies, cytokines and proteins) to alter an individual's immune response to treat disease.[36]

In IMID, such as rheumatoid arthritis and inflammatory bowel disease, biologic agents target a specific part of the individual's immune response against 'self' to stop the immune response creating inflammation and damage.[36] However, they also affect the immune response against genuine antigens and cause immunosuppression. Use of a combination of therapies may have a cumulative effect that increases the level of immunosuppression in an individual.

In atopic conditions and inflammation such as chronic spontaneous urticaria and allergic asthma, biologic agents inhibit the activation of allergen specific IgE antibodies and mast cells or decrease the number of eosinophils that contribute to allergy related inflammation.[36] These treatments do not cause immunosuppression.

Other biologic agents stimulate an individual's immune response by blocking immune checkpoints on healthy cells and cancer cells to increase their anti-tumour response, see section 4.3.2.

Live vaccines *can be* administered to individuals:

- receiving hydroxychloroquine, mesalazine/5-ASA, olsalazine and sulfasalazine
- with low-level immunosuppression regimens of azathioprine, 6-mercaptopurine or methotrexate
- receiving intra-ocular biologic therapy because such therapy does not usually result in immunosuppression
- taking omalizumab or mepolizumab to manage allergic conditions such as chronic spontaneous urticaria and allergic asthma.

Live vaccines *should not* be administered to individuals:

- with high-level immunosuppression regimens of azathioprine, 6-mercaptopurine or methotrexate
- receiving treatment with any dose of cyclophosphamide, cyclosporine, leflunomide, mycophenolate mofetil, or tacrolimus
- receiving treatment with monoclonal antibody inhibitors, TNF inhibitors and kinase inhibitors.

See Table 4.2 for guidelines according to each biologic agent.

Table 4.2: Guidelines for live vaccine administration for individuals receiving non-corticosteroid agents

	Dose regime	Administration of live vaccines	Dose regime	Administration of live vaccines
Non-biologic agent				
Locally injected biologic dose	Any agent, any dose Intra-ocular injection	Any time before, during or after dose		
Hydroxychloroquine Mesalazine/5-ASA Olsalazine Sulfasalazine	Any dose	Any time before, during or after treatment		
Azathioprine	≤3 mg/kg per day	Any time before, during or after treatment	>3mg/kg per day	Delay for 3 months after discontinuation
6-mercaptopurine	≤1.5 mg/kg per day		>1.5mg/kg per day	
Methotrexate	≤0.4 mg/kg per week		>0.4mg/kg per week	
Cyclophosphamide Cyclosporine Mycophenolate mofetil Tacrolimus			Any dose	Delay for 3 months after discontinuation
Leflunomide Teriflunomide			Any dose	Delay for 6 months after discontinuation
Biologic agent				
Omalizumab Mepolizumab	Any dose	Any time before, during or after dose		
Fingolimod Natalizumab			Any dose	Delay for 3 months after discontinuation
Axitinib Imatinib Ruxolitinib Tofacitinib			Any dose	Delay for 12 months after discontinuation
Atezolizumab Ipilimumab Nivolumab Pembrolizumab Sirolimus			Any dose	Delay for 6 months after discontinuation

Continued overleaf

	Dose regime	Administration of live vaccines	Dose regime	Administration of live vaccines
Abatacept Adalimumab Anakinra Etanercept Infliximab Rituximab Tocilizumab Trastuzumab			Any dose	Delay for 12 months after discontinuation
Ocrelizumab			Any dose	Delay for 3 years after discontinuation

For children aged under 18 years, see the Starship Clinical Guidelines *Immunosuppression and Immunisation in Rheumatology* (available at **www.starship.org.nz/guidelines/immunosuppression-infection-and-immunisation-in-rheumatology**).

For adults, see the IMAC factsheet *Diseases and medications when live vaccines may be contraindicated* (available at **www.immune.org.nz/resources/written-resources**).

Infants of mothers who received immunosuppressive biologic agents during pregnancy

In recent years there has been rapid development of targeted immunosuppressive biologic agents, and an increasing number of pregnant women are receiving such therapies. Common examples include adalimumab, infliximab and rituximab. Studies of the effects of these agents on the infant's immune system and ability to respond to vaccination are limited.[37]

Multiple factors influence the potential for these agents to be detected and/or cause immunosuppression in an infant for months after they are born. These include, the agent or combination of agents used, gestational age(s) when administered, ability of the agent(s) and/or their metabolites to cross the placenta, and time between administration of the last antenatal dose and the chronological age of the infant.[38]

> For infants aged under 12 months, please discuss immunosuppressive therapies taken during pregnancy with infant's mother or specialist, or contact IMAC (on 0800 IMMUNE /0800 466 863) before administration of rotavirus, BCG, MMR or VV vaccines.

Rotavirus vaccine

There is limited data on rotavirus vaccination safety when given to infants born to mothers receiving immunosuppressive therapy during pregnancy.[18, 37, 39] Although in most cases it is likely to be safe, caution is required. The level of circulating wild-type rotavirus is currently very low in New Zealand, therefore, the risk of gastroenteritis following rotavirus vaccination in this cohort of infants may be greater than the risk of acquiring the disease. The decision to administer rotavirus vaccine to infants born to mothers who received immunosuppressive agents (biologic agents) during pregnancy should be determined case by case.

If an infant turns 15 weeks of age before the first rotavirus vaccine dose can be administered, they will not be able to receive any rotavirus vaccine doses.

BCG, MMR and VV

Infants born to mothers who received immunosuppressive agents during pregnancy must not be vaccinated with a BCG vaccine until they are identified as being immunocompetent.

Normally, it is only recommended to give MMR and VV before age 12 months if there is an increased risk of exposure, such as during an outbreak or following close contact with a case (see sections 11.5.1, 11.8 and 21.8.3). Infants aged under 12 months born to mothers who received immunosuppressive agents during pregnancy should not be vaccinated with MMR or VV unless they are identified as being immunocompetent.

4.3.7 (Re)vaccination following immunosuppression

All vaccines on the Schedule are funded for vaccination or re-vaccination of individuals following immunosuppression. Note that the period of immunosuppression due to steroid or other immunosuppressive therapy must be longer than 28 days. The timing and number of doses should be discussed with the individual's specialist. Ideally, vaccination should be conducted prior to any planned immunosuppression. See also the relevant disease chapters.

4.3.8 Oncology

This section provides general guidelines for vaccination during and after cancer treatment. Specific vaccination questions should be discussed with an expert paediatrician, infectious diseases physician or oncologist.

Note: The exception to these guidelines is individuals being treated with immune checkpoint inhibitors for whom vaccination may be contraindicated (see section 4.3.2).

Vaccination during cancer chemotherapy

While administration of inactivated and subunit (non-live) vaccines is safe for individuals undergoing cancer chemotherapy (except immune checkpoint inhibitors as described in the previous section), their response and subsequent protection may be reduced compared with healthy individuals.

Influenza vaccination is recommended for children and adults prior to planned or when undergoing cancer chemotherapy as soon as the vaccine becomes available; there is no need to wait until three months after the individual's last treatment.[40, 41] Influenza vaccination can be administered at any time during a cancer chemotherapy cycle.[42]

In both children and adults, administration of two influenza vaccine doses a minimum of four weeks apart could improve the immune response to vaccination.[43]

Administration of live vaccines during cancer chemotherapy is absolutely contraindicated because of the risk of disseminated vaccine disease. For recommendations regarding vaccination of close contacts of immunocompromised individuals, see section 4.3.1.

Vaccination after cancer chemotherapy

In general, booster dose(s) of a diphtheria/tetanus/pertussis-containing vaccine, and hepatitis B, polio (IPV) and pneumococcal vaccines (PCV13 followed by 23PPV) should be given, from not less than three months after cancer chemotherapy has ended (except immune checkpoint inhibitors as described in section 4.3.2, when the lymphocyte count is $>1.0 \times 10^9$/L).

In general, administration of age-appropriate live vaccines should be delayed for at least six months after cancer chemotherapy. This interval may need to be extended according to:

- the intensity and type of therapy
- receipt of blood products or IG (see Table A6.1 in Appendix 6)
- underlying disease.

MMR vaccination is not required post-chemotherapy for adults born prior to 1969 or who have documented evidence of measles, mumps and rubella immunity (see section 11.8.3). Adults born in 1969 or later who do not have documented evidence of immunity to measles, mumps and rubella should receive up to two documented doses of MMR, as per the usual adult catch-up Schedule, at least six months post-chemotherapy and when their lymphocyte count is $>1.0 \times 10^9$/L.

For children aged under 18 years, see the Starship Clinical Guideline *Immunisation of children during and after cancer therapy* for age-appropriate schedules and worksheets (available at **www.starship.org.nz/guidelines/immunisation-of-children-during-and-after-cancer-therapy**).

For adults, see the IMAC factsheet *Immunisation for adults post-chemotherapy who are not taking immunosuppressive disease modifying drugs* (available at **www.immune.org.nz/resources/written-resources**).

Vaccination and radiotherapy

Individuals who are only receiving localised radiotherapy to treat a tumour or lesion can be vaccinated with subunit vaccines and live vaccines at any time prior to, during, or after radiotherapy.[44]

4.3.9 Haematopoietic stem cell transplantation

Haematopoietic stem cell transplantation (HSCT) is used to treat haematological disease, such as acute leukaemia, and some immunodeficiency syndromes, such as severe combined immunodeficiency. Transplant recipients undergo a conditioning regime to destroy their immune system and underlying disease then receive an infusion of cells to reconstitute a new immune system. The transplanted cells may be collected from bone marrow, umbilical cord blood, or peripheral blood. They may be donated by another person (called an allogeneic transplant), or may be the recipient's own cells that have been processed to ensure they are disease free (called an autologous transplant).[45]

After HSCT, it takes months to years for the recipient's new immune system to reconstitute and become functional. However, the age of the recipient, underlying disease, conditioning regime, type of transplantation and complications such as graft versus host disease (GVHD) can affect and prolong recovery time.[45, 46]

Vaccination of individuals post-HSCT

Initially, the recipient may have temporary measurable donor-derived protection against some diseases, but their reconstituted immune system will need full (re)vaccination to provide long-term protection against vaccine-preventable diseases. Administration of subunit vaccines, such as PCV13, may be recommended as early as three months post-HSCT. Annual influenza vaccination may be recommended from six months post-HSCT. It is generally recommended to commence immunisation with live viral vaccines no less than 24 months post-HSCT and in the absence of GVHD and immunosuppressive therapy.[46, 47]

For children aged under 18 years, see the Starship Clinical Guideline *Immunisation of children during and after cancer therapy* for age-appropriate schedules and worksheets (available at **www.starship.org.nz/guidelines/immunisation-of-children-during-and-after-cancer-therapy**).

For adults, see the vaccination protocol provided by the person's New Zealand-based haematology clinic or the IMAC factsheet *Immunisation for adults post-haematopoietic stem cell transplantation (HSCT)* (available at **www.immune.org.nz/resources/written-resources**).

For recommendations regarding vaccination of close contacts of immunocompromised individuals, see section 4.3.1.

4.3.10 Solid organ transplantation

Vaccination of individuals pre-/post solid organ transplantation

In addition to the usual Schedule vaccines, individuals who are pre-/post-solid organ transplantation are eligible to receive additional funded vaccines. Ideally, vaccination should be conducted prior to any planned immunosuppression.[48] An accelerated immunisation schedule is provided for infants with congenital biliary or renal conditions requiring transplant (see Table 4.3).

Additional funded vaccines may include hepatitis A vaccine; hepatitis B vaccine if the person was not previously vaccinated or does not have evidence of immunity (see section 8.5.4); *Haemophilus influenzae* type b (Hib-PRP), influenza, pneumococcal, meningococcal and varicella vaccines.

Live vaccines – caution

Live vaccines should also be administered at least four weeks before a predicted transplant. Administration of live vaccines (MMR and VV or ZV) is generally contraindicated post-transplantation due to immunosuppression. However, on a case-by-case basis with appropriate follow-up in place, a specialist may recommend that VV is administered less than four weeks before a predicted transplant or to a post-transplantation paediatric patient.[33]

See *Vaccines for individuals with acquired immunodeficiency* in section 4.3.4 for precautions and contraindications for the administration of live vaccines (MMR and VV or ZV), eligibility and recommendations for influenza, Hib, pneumococcal and meningococcal vaccines, and recommendations when an individual who is immunosuppressed/post-solid organ transplantation is a contact of a measles or chickenpox case.

It is recommended to follow an accelerated schedule of vaccinations for infants and children likely to be listed for solid organ transplantation, see Table 4.3 for infant recommendations.

> For pre-/post-solid organ transplantation advice for adult immunisation, see the IMAC factsheet Immunisation for adults pre-/post-solid organ transplantation (excluding kidney transplantation) or Immunisation for adults pre-dialysis, on dialysis or pre-/post-kidney transplant (both available at **www.immune.org.nz/resources/written-resources**).

For recommendations regarding vaccination of close contacts of immunocompromised individuals, see section 4.3.1.

Table 4.3: Accelerated vaccination schedule with additional vaccine recommendations for infants likely to require liver or kidney transplantation

Funded vaccines are in shaded rows. Refer to the Pharmaceutical Schedule (**www.pharmac.govt.nz**) for any changes to funding decisions.

Age	Vaccination	Comments
Do not start earlier than age 6 weeks.		
6 weeks	RV1 (Rotarix) PCV13[a] (Prevenar 13) DTaP-IPV-HepB/Hib (Infanrix-hexa)	PCV13 replaces PCV10 (Synflorix)
2 months	MenC (NeisVac-C)	If MenACWY-T (Nimenrix) not given
	MenACWY-T (Nimenrix)[b] 4CMenB (Bexsero)[c]	Not funded, need to be prescribed and purchased
3 months	RV1 PCV13[a] (Prevenar 13) DTaP-IPV-HepB/Hib (Infanrix-hexa)	PCV13 replaces PCV10
4 months	MenC (NeisVac-C)	If MenACWY-T (Nimenrix) not given
	MenACWY-T (Nimenrix)[b] 4CMenB[c]	Not funded; need to be prescribed and purchased
5 months	PCV13[a] (Prevenar 13) DTaP-IPV-HepB/Hib (Infanrix-hexa)	PCV13 replaces PCV10
6 months	Influenza (junior formulation)[d]	Give two doses 4 weeks apart in the first year receiving influenza vaccine, and one dose in subsequent years Give annually
7 months	MMR (Priorix)[e]	MMR should not be given less than 4 weeks before the predicted transplant
	Varicella (Varilrix)[e,f]	In general, VV should not be given less than 4 weeks before the predicted transplant but may be given closer at the discretion of the specialist
	HepA (Havrix Junior)	
	Check Anti-HBs serology	If anti-HBs is negative, give a further three doses of monovalent HepB vaccine (Engerix-B 20 µg) 4 weeks apart
9 months	MenACWY-D (Menactra)[g]	If MenACWY-T (Nimenrix) not given previously
12 months	PCV13 (Prevenar 13)[a]	PCV13 replaces PCV10
	MMR[e]	MMR should not be given less than 4 weeks before the predicted transplant

Continued overleaf

Age	Vaccination	Comments
12 months (continued)	Varicella (Varivax)[e]	In general, VV should not be given less than 4 weeks before the predicted transplant but may be given closer at the discretion of the specialist
	4CMenB (Bexsero)[c]	Not funded; needs to be prescribed and purchased Administer at least 6 months after previous dose, from age 12 months After 3 years, review the advice regarding administration of booster doses
13 months	DTaP-IPV-HepB/Hib (Infanrix-Hexa)	
	MMR (Priorix)	MMR should not be given less than 4 weeks before the predicted transplant
	MenACWY-D[g]	Give a booster after 3 years, then 5-yearly
	HepA (Havrix Junior)	
2 years	23PPV (Pneumovax 23)	Give one dose Revaccinate once after 5 years
4 years	DTaP-IPV (Infanrix-IPV)	
From age 9 years	HPV9 (Gardasil 9)	Give 3 doses at 0, 2 and 6 months
11 years	Tdap (Boostrix)	
6 months post-transplant	HepB (Engerix-B), plus anti-HBs serology before and 4 weeks after the initial HepB series	Give 3 doses of monovalent HepB vaccine (Engerix-B 20 ug) If HepB was not previously given, and anti-HBs is negative, give 3 doses of monovalent HepB vaccine If there is an inadequate immune response to the initial 3-dose HepB series, give a further 3 doses
	23PPV (Pneumovax 23)	If child is at least 24 months old and dose not given pre-transplant Revaccinate once after 5 years
	Influenza (age appropriate vaccine)[d]	For infants and children aged 6 months to under 9 years, give 2 doses 4 weeks apart in the first year of receiving the influenza vaccine, and 1 dose in subsequent years Give annually
12 months post-transplant	Resume the usual Schedule, except live vaccines	Live vaccines[h] are contraindicated post-transplantation
Household contacts of transplant recipients	National Immunisation Schedule vaccines	Immune-competent siblings and other household contacts may receive all the Schedule vaccines and should be fully vaccinated for their age.
	Influenza (with age-appropriate vaccine)[d]	Recommended annually for all family members but not funded.
	Varicella	Two doses of VV are funded for susceptible household contacts of transplant recipients.

a. A three-dose primary series plus a booster dose of PCV13, administered at 6 weeks, 3 months, 5 months, and 12 months, replaces PCV10 on the usual Schedule.

b. As MenACWY-D (Menactra) is only licensed from age 9 months, MenACWY-T (Nimenrix) can be used to give broader serotype protection to infants than MenC (NeisVac-C), but is not funded.

c. Recommended to administer prophylaxic paracetamol (or ibuprofen) to reduce fever in children age under 2 years (section 12.7.3).

d. Check **influenza.org.nz** website for most recent updates on funded influenza vaccine and appropriate age ranges.

e. MMR and VV can be given on the same day; if not, seek 4 weeks of separation between them.

f. Only Varilrix is available from hospital at ages 9 to <12 months; Varivax is not licensed under the age of 12 months.

g. Give MenACWY-D at least 4 weeks after PCV13 (see section 4.3.3).

h. On a case-by-case basis, a specialist may recommend that VV is administered to their post-transplantation paediatric patient.

4.3.11 Functional asplenia, hyposplenia and pre-/post-splenectomy

The spleen has an important role in initiating the immune response to encapsulated bacteria, including *Streptococcus pneumoniae*, *Neisseria meningitidis*, and *Haemophilus influenzae* type b (Hib), and removing them from the circulatory system.

There are three main reasons why an individual may not have a fully functioning spleen:

- congenital disorders (eg, asplenia, hyposplenia or polysplenia associated with a congenital syndrome)
- disease (eg, Coeliac disease, acute leukaemia)
- surgical removal (eg, trauma, autoimmune haemolytic anaemia).

Individuals with reduced spleen function or an absent spleen are at increased risk of overwhelming infection by encapsulated bacteria.[49] This is a medical emergency and carries a high mortality rate. The risk of overwhelming infection after splenectomy is more than 50 times higher than the risk in the general population. Opinion is divided on whether this level of risk is life-long or decreases over time after the splenectomy.

Vaccination of individuals with asplenia or hyposplenia or pre-/post-splenectomy

No vaccines are contraindicated for individuals with functional or anatomical asplenia (pre-/post-splenectomy), and they are eligible for additional funded influenza, Hib, pneumococcal and meningococcal vaccines. Providers should also ensure that they are up to date with Schedule vaccines, including Tdap and MMR.

When a splenectomy is planned, individuals should ideally complete the vaccinations they require up to two weeks prior to their surgery. If this is not possible, preferably administer vaccines until 14 days before the splenectomy and continue from seven days after the splenectomy, or prior to discharge from hospital, if sooner. When the splenectomy is unexpected, for example due to trauma, commence vaccination from seven days after surgery or prior to discharge from hospital. In all cases a vaccination plan must be formulated and communicated to the GP for completion (see Table 4.4).

Individuals with reduced spleen function (eg, because of disease or partial splenectomy), are recommended (but not funded) to receive pneumococcal and meningococcal vaccines and annual influenza vaccination.

See *Vaccines for individuals with acquired immunodeficiency* in section 4.3.4 for eligibility and recommendations for influenza, Hib, pneumococcal and meningococcal vaccines.

Table 4.4 summarises the additional vaccine recommendations and schedules for infants and children aged under 18 years with functional or anatomical asplenia. The funded vaccines are shown in shaded rows.

For adults, see the IMAC factsheet *Immunisation for adults pre-/post-splenectomy or with functional asplenia* (available at **www.immune.org.nz/resources/written-resources**).

Table 4.4: Additional vaccine recommendations for infants and children aged under 18 years with functional or anatomical asplenia

Funded vaccines are in the shaded rows.
Refer to the Pharmaceutical Schedule (**www.pharmac.govt.nz**) for any changes to funding decisions.

Relevant age	Vaccine (trade name)	Recommended vaccination schedule
Under 12 months when diagnosed with functional asplenia or pre- or post-splenectomy[a]	PCV13 (Prevenar 13)[b]	Give PCV13 [b] at ages 6 weeks, and 3, 5 and 12–15 months or an age-appropriate catch-up schedule: • **If aged under 7 months**, replace PCV10 with PCV13 from the next visit. Give PCV13 [b] at ages 6 weeks, 3 months, 5 months and 12 months • For those who **have not been immunised** age 7–11 months: give 2 doses of PCV13 (8 weeks apart) and a further dose at least 8 weeks later, from age 12 months • For children aged 7–11 months **who have completed** a 2-dose primary course with PCV10, give 1 dose of PCV13 as soon as possible and another dose (of PCV13) at least 8 weeks later, from age 12 months
	23PPV (Pneumovax 23)	Following completion of the PCV schedule, give 1 dose at least 8 weeks after the last PCV13 dose, from age 2 years • Revaccinate once after 5 years
	MenC (NeisVac-C) and MenACWY-D (Menactra)[c]	• If aged under 9 months, give 2 doses of MenC 8 weeks apart, followed by MenACWY-D [c] at ages 9 and 13 months. Administer one MenACWY-D booster dose after 3 years, then 5-yearly. See alternative unfunded MenACWY-T (Nimenrix) option below • If aged 9–11 months, give 2 doses of MenACWY-D[c] at least 3 months apart, followed by a booster dose after 3 years, then 5-yearly
	4CMenB (Bexsero)[d]	Not funded; needs to be prescribed and purchased • Give two doses at least 8 weeks apart followed by a booster dose at least 6 months later, from age 12 months
	MenACWY-T (Nimenrix)	Licensed from 6 weeks; can be used in place of MenC doses to offer broader protection. Not funded; needs to be prescribed and purchased. Give 2 doses at least 8 weeks apart. A booster dose of MenACWY-D[c] (funded) or MenACWY-T (unfunded) is recommended at age 12 months or older
	Influenza (junior formulation)[e]	Annual vaccination from age 6 months. • In the first year, give 2 doses 4 weeks apart, then 1 dose in each subsequent year

Continued overleaf

Relevant age	Vaccine (trade name)	Recommended vaccination schedule
Aged 12 months to under 18 years when diagnosed with functional asplenia or pre- or post-splenectomy[a]	PCV13	• Children aged 12–59 months, who have not yet received any PCV13: – give 2 doses of PCV13 at least 8 weeks apart[f] • Children aged 5 years to under 18 years: – give 1 dose of PCV13 even if fully vaccinated[g]
	23PPV (Pneumovax 23)	Following completion of the PCV schedule, give 1 dose at least 8 weeks after the last PCV13 dose, from age 2 years. Revaccinate once after 5 years.
	MenACWY-D (Menactra)[c]	• If aged 12 months to under 8 years at diagnosis, give 2 doses of MenACWY-D at least 3 months apart followed by a booster dose after 3 years, then 5-yearly[c] • If aged 8 years or older give 2 doses of MenACWY-D 8 weeks apart followed by a booster dose 5-yearly[c]
	4CMenB (Bexsero)[d]	Not funded; needs to be prescribed and purchased. • From age 12 months, give 2 doses 8 weeks apart • After 3 years, review the advice regarding administration of booster doses
	Hib-PRP-T (Hiberix)	• If child is aged 12–15 months, give 1 dose at age 15 months as per the Schedule • If aged 16 months to under 5 years and has not received a single Hib-PRP-T dose after age 12 months, give 1 dose • If aged 5 years or older, give 1 dose, unless fully vaccinated
	Influenza (age appropriate vaccine)[e]	Give annually • In previously unvaccinated children age <9 years, give 2 doses 4 weeks apart, then 1 dose in each subsequent year

a. Where possible, the vaccines should be administered at least 14 days before elective splenectomy and continue from 7 days after the splenectomy. For emergency splenectomy, the vaccines should be administered from 7 days post-operatively or prior to discharge from hospital.

b. A three-dose primary series plus a booster dose of PCV13, administered at 6 weeks, 3 months, 5 months, and 12 months, replaces PCV10 on the usual Schedule.

c. Give MenACWY-D at least 4 weeks after PCV13 (see section 4.3.3).

d. It is recommended to administer prophylactic paracetamol (or ibuprofen) to reduce fever in children age under 2 years (see section 12.7.3).

e. Check **influenza.org.nz** for most recent influenza vaccine brands and appropriate age ranges.

f. There are no safety concerns, regardless of the interval between the last dose of PCV10 and the first dose of PCV13.

g. If 23PPV has already been given (prior to any doses of PCV13) to children aged under 18 years, wait at least 8 weeks before administering PCV13 (note – this differs from a 1 year gap recommended in adults).

4.3.12 HIV infection

Human immunodeficiency virus (HIV) infects CD4+ T cells leading to a progressive decline in CD4 cell count, increasing immunodeficiency and vulnerability to infection, and suboptimal responses to vaccines.

The efficacy of any vaccine may be reduced in HIV-positive individuals, and antibody levels within these individuals may wane faster than in individuals who are HIV-negative. Although antiretroviral therapy may improve immune responses, it is unlikely these individuals will achieve the levels of antibodies seen in individuals who are HIV-negative. Serological testing and the need for additional doses (eg, HepB: see section 8.5.7 and Table 8.6) should be discussed with the individual's specialist.

Vaccination of individuals with HIV infection

In addition to the usual Schedule vaccines, individuals who are HIV-positive to receive additional funded vaccines including Hib, pneumococcal, and meningococcal vaccines. Individuals who are HIV-positive are also eligible to receive funded influenza vaccination.

Live vaccines – caution

It is recommended that infants who are HIV-positive receive rotavirus vaccine as per the Schedule. Administration of BCG vaccination is contraindicated for all HIV-positive individuals regardless of their CD4+ percentage/count.[50]

MMR and VV may be administered as per the Schedule to:

- children aged 1–13 years who have a recent CD4+ lymphocyte percentage of ≥15 percent
- children aged 14 years to under 18 years who have a recent CD4+ count of ≥200 cells/ml
- MMR, VV and ZV can be administered as per the Schedule to adults aged 18 years or older who have a recent CD4+ lymphocyte count of ≥200 cells/mm^3.[49]

See *Vaccines for individuals with acquired immunodeficiency* in section 4.3.4 for eligibility and recommendations for influenza, Hib, pneumococcal and meningococcal vaccines.

Table 4.5 (for children aged under 5 years when diagnosed) and Table 4.6 (for children aged 5 to under 18 years) summarise additional vaccine recommendations and schedules for HIV-positive children. The funded vaccines are shown in shade rows.

For adults, see the IMAC factsheet *Immunisation for adults with HIV infection* (available at **www.immune.org.nz/resources/written-resources**).

Table 4.5: Additional vaccine recommendations for children aged under 5 years when diagnosed with HIV

Note: HIV-positive children should receive the usual Schedule vaccines, including rotavirus vaccine for infants; BCG should not be given; MMR and VV may be administered as per the recommendations below. **Funded vaccines are in shaded rows.** Refer to the Pharmaceutical Schedule (**www.pharmac.govt.nz**) for any changes to funding decisions.

Relevant age	Vaccine (trade name)	Recommended vaccine schedule
Infants aged under 12 months when diagnosed	PCV13 (Prevenar 13)[a]	Give PCV13[a] at ages 6 weeks and 3, 5 and 12–15 months or an age-appropriate catch-up schedule: • **If aged under 7 months**, replace PCV10 with PCV13 from the next visit. Give PCV13[a] at ages 6 weeks, 3 months, 5 months and 12 months • For those **who have not been immunised** age 7–11 months: give two doses of PCV13 (8 weeks apart) and a further dose at least 8 weeks later, from age 12 months • For children aged 7–11 months **who have completed** a 2-dose primary course with PCV10, give 1 dose of PCV13 as soon as possible and another dose (of PCV13) at least 8 weeks later, from age 12 months
	23PPV (Pneumovax 23)	Following completion of the PCV schedule, give one dose at least 8 weeks after the last PCV13 dose, from age 2 years Revaccinate once after 5 years
	MenC (NeisVac-C) and MenACWY-D (Menactra)[b]	• If aged under 9 months, give 2 doses of MenC 8 weeks apart, followed by MenACWY-D at ages 9 and 13 months[b] Administer one MenACWY-D booster dose after 3 years, then 5-yearly See alternative unfunded MenACWY-T (Nimenrix) option below • If aged 9–11 months, give 2 doses of MenACWY-D at least 3 months apart, followed by a booster dose after 3 years, then 5-yearly
	4CMenB (Bexsero)[c]	Not funded; needs to be prescribed and purchased Give 2 doses at least 8 weeks apart followed by a booster dose at least 6 months later, from age 12 months
	MenACWY-T (Nimenrix)	Licensed from age 6 weeks, can be used in place of MenC doses. Not funded; needs to be prescribed and purchased. Give 2 doses at least 8 weeks apart A booster dose of MenACWY-D[b] (funded) or MenACWY-T (unfunded) is recommended at age 12 months or older
	Influenza (junior formulation)[d]	Annual vaccination from age 6 months In the first year, give 2 doses 4 weeks apart, then 1 dose in each subsequent year

Continued overleaf

Relevant age	Vaccine (trade name)	Recommended vaccine schedule
Children aged 12 months to under 5 years when diagnosed	PCV13	• Children aged 12–59 months, who have not yet received any PCV13, give 2 doses of PCV13 at least 8 weeks apart[e] • Children aged 5 years to under 18 years, give 1 dose of PCV13 even if fully vaccinated[f]
	23PPV (Pneumovax 23)	Following completion of the PCV schedule, give 1 dose at least 8 weeks after the last PCV13 dose, from age 2 years Revaccinate once after 5 years
	Influenza (age appropriate vaccine) [d]	Give annually In previously unvaccinated children, give 2 doses 4 weeks apart, then 1 dose in each subsequent year.
	MMR[g] (Priorix)	If CD4+ lymphocyte percentage is ≥15%: • give the first MMR dose at age 12 months, followed by the 2nd dose 4 weeks later
	Varicella[g] (Varivax)	If CD4+ lymphocyte percentage is ≥15%: • give 2 doses (starting 4 weeks after the 2nd MMR), at least 3 months apart
	MenACWY-D[b] (Menactra)	Give 2 doses of MenACWY-D at least 3 months apart followed by a booster dose after 3 years, then 5-yearly[b]
	4CMenB (Bexsero)[c]	Not funded, needs to be prescribed and purchased From age 12 months, give 2 doses 8 weeks apart After 3 years, review the advice regarding administration of booster doses

a. A three-dose primary series plus a booster dose of PCV13, administered at 6 weeks, 3 months, 5 months, and 12 months, replaces PCV10 on the usual Schedule.

b. Give MenACWY-D at least 4 weeks after PCV13[31] (see section 4.3.3).

c. Recommended to administer prophylaxic paracetamol (or ibuprofen) to reduce fever in children age under 2 years (see section 12.7.3)

d. Check **influenza.org.nz** for most recent influenza vaccine brands and appropriate age ranges.

e. There are no safety concerns, regardless of the interval between the last dose of PCV10 and the first dose of PCV13.

f. If 23PPV has already been given (prior to any doses of PCV13) to children aged under 18 years, wait at least 8 weeks before administering PCV13 (note – this differs from a 1-year gap recommended in adults).

g. Only a single live vaccine is recommended at each visit for individuals with HIV infection. A minimum interval of 4 weeks is required between live vaccine doses administered at different visits.

Table 4.6: Additional vaccine recommendations for children aged 5 to under 18 years when diagnosed with HIV

Note: HIV-positive children should receive the usual Schedule vaccines, MMR and varicella vaccines may be administered as per the recommendations below. **Funded vaccines are in shaded rows.**

Refer to the Pharmaceutical Schedule (**www.pharmac.govt.nz**) for any changes to funding decisions.

Vaccine (trade name)	Recommended vaccine schedule
HPV9 (Gardasil 9)[a]	From age 9 years, give 3 doses of HPV at 0, 2 and 6 months[a]
PCV13 (Prevenar 13)[b]	For children who have not previously received PCV13, give 1 dose of PCV13[b]
23PPV (Pneumovax 23)	Give 1 dose of 23PPV at least 8 weeks after the PCV13 dose. Revaccinate once with 23PPV, 5 years after the first 23PPV
MenACWY-D (Menactra)[c]	• If aged 5 years to under 8 years give 2 doses of MenACWY-D 8 weeks apart followed by a booster dose after 3 years and then 5-yearly[c] • If aged 8 years or older give 2 doses of MenACWY-D 8 weeks apart followed by a booster dose followed by a booster dose 5-yearly[c]
4CMenB (Bexsero)	Not funded, needs to be prescribed and purchased • Give 2 doses 8 weeks apart After 3 years review the advice regarding administration of booster doses
MMR[d] (Priorix)	If aged ≤13 years and CD4+ lymphocyte percentage is ≥15%, or if aged ≥14 years and CD4+ lymphocyte count is ≥200 cells/mm^3: • give 2 doses of MMR at least 4 weeks apart
Varicella[d] (Varivax)	If no history of varicella disease or vaccination, and • if aged ≤13 years and CD4+ lymphocyte percentage is ≥15%, or • if aged ≥14 years and CD4+ lymphocyte count is ≥200 cells/mm^3: – give 2 doses (starting 4 weeks after 2nd MMR) at least 3 months apart
Influenza (Afluria Quad)	• If aged under 9 years give 2 doses 4 weeks apart in the first year receiving influenza vaccine (both doses are funded), and 1 dose in subsequent years • If aged 9 years or older give 1 dose • Give annually

a. HPV9 is approved for use from age 9 years.

b. If 23PPV has already been given (prior to any doses of PCV13) to children aged under 18 years, wait at least 1 year before administering PCV13.

c. Give MenACWY-D at least 4 weeks after PCV13 (see section 12.4.4).

d. Only a single live vaccine is recommended at each visit for individuals with HIV infection. A minimum interval of 4 weeks is required between live vaccine doses administered at different visits.

Source: Starship Child Health

4.4 Chronic kidney disease

Individuals immunised during the early stages of chronic kidney disease (CKD) generally respond to vaccination. However, the immune system response to

vaccination decreases with advancing kidney disease.[51, 52] Cases of children developing a disease for which they have serological evidence of immunity have been reported.[52]

Individuals with nephrotic syndrome, kidney failure or end-stage kidney disease (CKD stages 4–5) have an increased risk of peritonitis and/or sepsis caused by encapsulated bacteria, *Streptococcus pneumoniae*, *Haemophilus influenzae* type b and *Neisseria meningitidis*.[51, 52, 53] Individuals on haemodialysis have an increased risk of exposure to hepatitis B virus. Adults with CKD also have an increased risk of zoster.[54]

Vaccination of individuals with chronic kidney disease

Individuals with CKD who are not receiving immunosuppressive therapy to manage their condition can receive vaccination as per the usual Immunisation Schedule. In addition to the usual Immunisation Schedule vaccines, individuals with CKD may be eligible to receive additional funded vaccines. These should be given as soon as the individual meets the eligibility criteria (eg, CKD stages 4–5: pre-dialysis, on dialysis, pre-kidney transplant, post-kidney transplant).

Additional funded vaccines may include hepatitis A, hepatitis B, *Haemophilus influenzae* type b (Hib), pneumococcal, and meningococcal vaccines. Individuals with CKD are also eligible to receive funded influenza vaccination.

Live vaccines – caution

Administration of live vaccines (MMR and VV or ZV) are generally contraindicated for individuals who are immunosuppressed because of the risk of disseminated vaccine disease. However, individuals with CKD who are considered to have minimal immunosuppression may be able to receive VV.[35]

See *Vaccines for individuals with acquired immunodeficiency* in section 4.3.4 for eligibility and recommendations for influenza, *Haemophilus influenzae* type b (Hib), pneumococcal and meningococcal vaccines.

There is no relationship between vaccination and deterioration of renal function or a reduction in the efficacy of dialysis.[52]

For children aged under 18 years, see the Starship Clinical Guideline *Renal vaccination record for Starship paediatric CKD* (available at **www.starship.org.nz/guidelines/renal-vaccination-record-for-starship-paediatric-ckd**).

For adults, see the IMAC factsheet *Immunisation for adults pre-dialysis, on dialysis or pre-/post-kidney transplant* (available at **www.immune.org.nz/resources/written-resources**).

4.5 Chronic liver disease

Chronic liver disease in infants and children may present as part of a congenital syndrome. They may have other conditions (eg, infants with biliary atresia may also have a non-functioning spleen) and eligibility for additional funded vaccines.

4.5.1 Vaccination of individuals with chronic liver disease

Individuals with chronic liver disease who are not receiving immunosuppressive therapy to manage their condition can receive vaccination as per the usual Schedule.

In addition to the usual Schedule vaccines, infants and children with chronic liver disease are eligible to receive funded hepatitis A vaccination from 12 months of age (see section 7.5.1). However, if they are likely to require a liver transplant an accelerated vaccination schedule may be advised as per Table 4.3. The aim of the accelerated schedule is to maximise protection against vaccine-preventable diseases and to deliver live vaccines prior to transplantation and immunosuppression. Prior to transplantation, hepatitis A vaccine could be administered from as early as 7 months of age. Additional pre-transplantation funded vaccines include influenza, pneumococcal, meningococcal, and varicella vaccines (see section 4.3.1).

It is recommended that adults with chronic liver disease receive influenza vaccination annually but this is not currently funded. Adults who are likely to require a liver transplant are eligible for additional funded vaccines, including hepatitis A vaccine; hepatitis B vaccine, if the individual was not previously vaccinated or does not have evidence of immunity; *Haemophilus influenzae* type b (Hib), influenza, pneumococcal, meningococcal and varicella vaccines (see section 4.3.10).

4.6 Other special groups

It is recommended that all individuals receive vaccination as per the usual Schedule except when pre-vaccination screening identifies a contraindication for a specific vaccine (see section 2.1.4). Additional vaccines may be recommended (but are not always funded) for individuals with some conditions or in some circumstances not previously discussed in this chapter. Table 4.7 lists other special groups and recommended additional vaccines. Funded vaccines are shown in shaded rows.

Table 4.7: Additional vaccine recommendations other special groups

Funded vaccines are in shaded rows. See the table footnotes for more information when indicated. Vaccinators are advised to check the Pharmaceutical Schedule (**www.pharmac.govt.nz**) for any changes to funding decisions.

Special group	Recommended vaccines
Individuals: • with cerebrospinal fluid (CSF) leak • chronic pulmonary disease, including asthma treated with high-dose corticosteroid therapy and cystic fibrosis • receiving corticosteroid therapy for more than two weeks and who are on an equivalent daily dosage of prednisone of 2 mg/kg per day or greater, or children who weigh more than 10 kg on a total daily dosage of 20 mg or greater • diabetes • intracranial shunt • receiving radiotherapy	Children, aged under 5 years • PCV13, 23PPV • Influenza, annually Children aged 5 years to under 18 years, (including for those who received four doses of PCV10) • PCV13, 23PPV • Influenza, annually
• living in boarding schools, hostels, university halls of residence, or other close quarters[a,b]	MenACWY[a,b] MMR (if susceptible) 4CMenB Hepatitis B (if susceptible) VV (if susceptible) Influenza, annually
• with cochlear implants	*Haemophilus influenzae* type b (Hib-PRP-T) Influenza, annually Pneumococcal (PCV13, 23PPV)
• living in correctional facilities[a,b]	MenACWY[a,b] MMR (if susceptible) Hepatitis B (if susceptible) Influenza, annually 4CMenB
• with error of metabolism at risk of major metabolic decompensation	Influenza, annually Varicella (VV)
	Continued overleaf
• with rheumatic heart disease	Influenza, annually
• who are case contacts of an individual with hepatitis A	Hepatitis A (if susceptible)
• with hepatitis B infection	Hepatitis A (if susceptible)
• who are household or sexual contacts of an individual with hepatitis B	Hepatitis B (if susceptible)
• with hepatitis C infection	Hepatitis A (if susceptible) Hepatitis B (if susceptible)
• with a needle-stick injury	Hepatitis B (if susceptible)
• who have had non-consensual sexual intercourse	Hepatitis B (if susceptible)
Intravenous drug users	Hepatitis A (if susceptible) Hepatitis B (if susceptible) Influenza, annually

Special group	Recommended vaccines
Men who have sex with men	HPV[c] Hepatitis A (if susceptible) Hepatitis B (if susceptible)
Case contacts of an individual with meningococcal disease	Group appropriate meningococcal vaccine[d]
Children at risk of exposure to tuberculosis	BCG vaccination for children aged under 5 years who: • will be living in a house or family/whānau with a person with either current TB or a history of TB • have one or both parents or household members or carers who within the last five years lived for a period of six months or longer in countries with a TB rate ≥40 per 100,000 • during their first five years will be living for three months or longer in a country with a TB rate ≥40 per 100,000. See Appendix 8 for a list of countries with a TB rate of ≥40 per 100,000 population

a. One dose of MenACWY-D (Menactra) is funded for individuals aged 13–25 years inclusively who are entering within the next 3 months, or who are in their first year of living in a boarding school hostel, tertiary education halls of residence, military barrack, or prison. Both MenACWY-D (Menactra) and MenACWY-T (Nimenrix) are available but unfunded for individuals who do not meet these criteria.

b. From 1 December 2019 to 30 November 2020, one dose of MenACWY-D is funded for individuals aged 13–25 years inclusively who are currently living in a boarding school hostel, tertiary education halls of residence, military barrack, or prison.

c. Three doses are funded for those aged 26 years or under.

d. To be determined by the Medical Officer of Health in an outbreak situation.

4.7 Immigrants and refugees

Adults and children who enter New Zealand as refugees or immigrants will need an assessment of their **documented** vaccination status and an appropriate planned catch-up programme. The programme may require modification based on **documented** doses: only clearly documented doses should be considered as given. If there is no documented vaccination history, plan the catch-up schedule assuming the vaccines have not been given, see Appendix 2 for catch-up schedules.

Immunisation schedules vary from country to country. Check all migrant and former refugee children immunisation records to ensure they are up to date with the New Zealand Schedule, in particularly ensure they have received MMR as opposed to a measles-rubella vaccine only.

For assistance with planning catch-up schedules, contact your local immunisation coordinator; or call IMAC on 0800 IMMUNE/0800 466 863, or discuss with an experienced colleague.

All children aged under 18 years are eligible to receive Schedule vaccines and Well Child Tamariki Ora services regardless of their immigration and citizenship status, and providers can claim the immunisation benefit for administering the vaccines.

Adult refugees aged 18 years or older are eligible to receive Schedule vaccines, and providers can claim the immunisation benefit for administering the vaccines. Non-residents who were aged under 18 years when they commenced HPV vaccination are currently funded to complete the course, even if they are aged 18 years or older when they complete it. Other adults aged 18 years or older must meet all the applicable eligibility criteria described in the *Health and Disability Services Eligibility Direction 2011* to receive funded healthcare services, including Schedule vaccines. For more information about eligibility for publicly funded services, see the Ministry of Health website (**www.health.govt.nz/eligibility**).

See also the *Recommendations for Comprehensive Post-Arrival Health Assessment for People from Refugee-like Backgrounds (2016 edition)*, available on the Australasian Society for Infectious Diseases website (**www.asid.net.au/resources/clinical-guidelines**).

Tuberculosis

In New Zealand, BCG vaccination is recommended and funded for infants and children aged under 5 years at increased risk of tuberculosis (TB). For further details, see section 20.5.2 and the Ministry of Health *Guidelines for Tuberculosis Control in New Zealand, 2019* (available at **www.health.govt.nz/publication/guidelines-tuberculosis-control-new-zealand-2019**).

Quota refugees are screened for active TB prior to arrival in New Zealand. If they are found to have active TB, their arrival is delayed until they are treated. The requirement for active TB screening of visitors and immigrants to New Zealand varies, dependent on the country they are coming from and/or how long they intend to stay in New Zealand.[55] In New Zealand over 2010–2016, the highest number of new TB cases were in people born overseas followed by people living with a person born overseas. Over 2012–2016, the average time between arrival in New Zealand and a new diagnosis of TB was around five years.[56] See section 20.3.2 for risk factors and Appendix 8 Table A8.1 for a countries with high incidence of TB.

Medical practitioners and laboratories are required to notify the Medical Officer of Health of suspected or confirmed cases of active TB. A person who has, or is suspected to have, active TB is entitled to the same level of funded health services as New Zealand citizens can expect.[55]

Hepatitis B

If a member of a refugee or immigrant family is found to be a hepatitis B carrier, it is recommended that all the family be screened, and vaccination offered to all those who are non-immune. Even if no one in the family is a hepatitis B carrier, it is recommended

that all children aged under 18 years be vaccinated against hepatitis B. See chapter 8 for more information and Appendix 2 for catch-up schedules.

Varicella

Individuals who have grown up in the tropics are less likely to have had chickenpox in childhood and may be non-immune as adolescents and adults. Adult chickenpox can be severe, and maternal varicella occurring in the first half of pregnancy can cause the rare but devastating congenital varicella syndrome (see Table 21.4). If there is no history of chickenpox, VV should be offered (although it is currently not funded).

4.8 Occupation-related vaccination

Certain occupations result in increased risk of contracting some vaccine-preventable diseases. Some infected workers, particularly health care workers and those working in early childhood education services, may transmit infections such as influenza, rubella, measles, mumps, varicella and pertussis to susceptible contacts, with the potential for serious outcomes.

Where workers are at significant occupational risk of acquiring a vaccine-preventable disease, the employer should implement a comprehensive occupational vaccination programme, including vaccination policies, staff vaccination records, information about the relevant vaccine-preventable diseases and the management of vaccine refusal. Employers should take all reasonable steps to encourage susceptible workers to be immunised. For information on what is required as evidence of immunity against vaccine preventable diseases, see the IMAC factsheet *Occupation related immunisation* (available at **www.immune.org.nz/resources/written-resources**).

The vaccines in Table 4.8 are recommended for certain occupational groups. In addition to the vaccines listed here, all adults should be up to date with age-appropriate Schedule vaccines (see section A2.3 in Appendix 2 for catch-up vaccination advice for adults aged 18 years or older).

If a non-immune individual is exposed to a vaccine-preventable disease, post-exposure prophylaxis and control measures should be administered where indicated (see the relevant disease chapters and the *Communicable Disease Control Manual,* available at **health.govt.nz/publication/communicable-disease-control-manual**).

Table 4.8: Recommended vaccines, by occupational group

Occupation	Recommended vaccines
Health care workers	
Medical staff, nursing staff, lead maternity carers, other health professional staff and students	Tdap – at least every 10 years IPV MMR Varicella Hepatitis A (if working with children) Hepatitis B Influenza, annually
Carers	
Health care assistants, long-term facility carers and nursing home staff	Tdap – at least every 10 years IPV MMR Varicella Hepatitis A (if exposed to faeces) Hepatitis B Influenza, annually
Individuals who work with children	
Early childhood education services staff	Tdap – at least every 10 years IPV MMR Varicella Hepatitis A Hepatitis B Influenza, annually
Other individuals working with children, including: • correctional staff working where infants/children live with mothers • school teachers (including student teachers) • outside school hours carers • child counselling services workers • youth services workers	Tdap – at least every 10 years IPV MMR Varicella Influenza, annually

Continued overleaf

Occupation	Recommended vaccines
Emergency and essential service workers	
Police and emergency workers	Tdap – at least every 10 years IPV MMR Varicella Hepatitis B Influenza, annually
Armed forces personnel	Tdap – at least every 10 years IPV MMR Varicella Hepatitis A (if deployed to high-risk countries) Hepatitis B Influenza, annually MenACWY (if living in close quarters and/or deployed to high-risk countries) 4CMenB (if living in close quarters) Yellow fever, rabies, typhoid, Japanese encephalitis (as appropriate, if deployed to high-risk countries)
Staff of correctional facilities	Tdap – at least every 10 years IPV MMR Varicella Hepatitis B Influenza, annually
Staff of immigration/refugee centres	Tdap – at least every 10 years IPV MMR Varicella Hepatitis B Influenza, annually

Continued overleaf

Occupation	Recommended vaccines
Individuals who work with animals	
Veterinarians, veterinary students and veterinary nurses	Tdap IPV MMR Influenza, annually
Zoo staff who work with primates	Tdap IPV MMR Hepatitis A Influenza, annually
Poultry workers and others handling poultry, including those who may be involved in culling during an outbreak of avian influenza, and swine industry workers	Tdap IPV MMR Influenza, annually
Individuals exposed to human tissue, blood, body fluids or sewage	
Laboratory staff	Tdap IPV MMR Varicella Hepatitis A (if exposed to faeces) Hepatitis B Influenza, annually MenACWY and 4CMenB (if regularly working with *Neisseria meningitidis* cultures)
Workers who perform skin penetration procedures (eg, tattooists, body-piercers)	Tdap IPV MMR Hepatitis B
Funeral workers, embalmers and other workers who have regular contact with human tissue, blood or body fluids and/or used needles or syringes	
Sewage workers, plumbers or other workers in regular contact with untreated sewage	Tdap IPV MMR Hepatitis A Hepatitis B
Sex workers	Tdap IPV MMR Hepatitis B HPV

a. One dose of MenACWY-D (Menactra) is funded for individuals aged 13–25 years inclusively who are entering within the next 3 months, or who are in their first year of living in a boarding school hostel, tertiary education halls of residence, military barracks, or prison.

b. From 1 December 2019 to 30 November 2020, one dose of MenACWY-D is funded for individuals aged 13–25 years inclusively who are currently living in a boarding school hostel, tertiary education halls of residence, military barracks or prison.

4.9 Travel

All travellers should be encouraged to consider vaccination requirements well in advance of overseas travel, including those who travel frequently for work or to visit family. It is recommended that they are up to date with age-appropriate Schedule vaccines (see Appendix 2 for advice on planning catch-up vaccination) and receive current information on overseas travel requirements (eg, typhoid, yellow fever, rabies, Japanese encephalitis vaccination).

Travellers can seek advice from a primary care practice with expertise in travel medicine or a specialist travel medicine clinic. Information is also available on the New Zealand Safe Travel (**safetravel.govt.nz**) and WHO (**www.who.int/ith/en/**) websites.

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