

PART 2: VACCINATION FOR SPECIAL RISK GROUPS

2.1 VACCINATION FOR ABORIGINAL AND TORRES STRAIT ISLANDER PEOPLE

Introduction

Aboriginal and Torres Strait Islander people experience a much greater burden of infectious disease than do other Australians. Much if not all of this excess burden of infectious diseases is probably related to living conditions and is much more clearly documented in remote regions of Australia than in urban areas. Although the high incidence of infection is most prominent in children, Aboriginal and Torres Strait Islander adults also experience very high rates of some infections, such as invasive pneumococcal disease and pneumonia. Some of these infections are vaccine-preventable. For specific recommendations on administration of individual vaccines, see relevant chapters.

Immunisation providers, including Aboriginal Community Controlled Health Services, play an important role in reducing the morbidity and mortality from these infections. It is important that Aboriginal and Torres Strait Islander people receive information and discuss their individual risks for specific infections, for example from influenza and pneumococcal infection, with their health practitioner. In order for this to occur, identification of Aboriginal or Torres Strait Islander status is necessary. As a first step, practitioners can ensure that each patient or parent of a child is asked the appropriate question as part of the routine pre-questioning for service provision and within the context and safe environment of a confidential consultation. For example: "Do you describe yourself, or your child, as an Aboriginal or Torres Strait Islander person?" Identification of children who are Aboriginal or Torres Strait Islander on the Australian Childhood Immunisation Register (ACIR) is important both for tracking coverage, especially in non-remote areas, and for vaccines such as pneumococcal conjugate vaccine which are specifically targeted for them.

The diseases and the vaccines

(i) Children

There are several differences in the standard vaccination schedule recommended for Aboriginal and Torres Strait Islander children. This is primarily a result of differences in the age-specific incidence of vaccine-preventable diseases between Aboriginal and Torres Strait Islander children and non-Indigenous children. It is therefore recommended that some Aboriginal and Torres Strait Islander children routinely receive, in addition to the vaccines on the Australian Standard Vaccination Schedule (ASVS), BCG and hepatitis A vaccine. These differences are referred to in the relevant chapters and are highlighted below.

- (a) **Tuberculosis and BCG vaccine.** Aboriginal and Torres Strait Islander Australians are at increased risk of acquiring tuberculosis.¹ Although there is uncertainty about the efficacy of BCG in preventing pulmonary tuberculosis, it seems to be particularly protective against disseminated forms of the disease. BCG is recommended for Aboriginal and Torres Strait Islander neonates in 'regions of high incidence'. It is usually administered to eligible infants by hospital staff (ie. midwives or nurses who have been specially trained) soon after delivery (see also Part 3.25, 'Tuberculosis').
- (b) ***Haemophilus influenzae* type b (Hib).** Before the introduction of an effective *Haemophilus influenzae* type b (Hib) vaccine, not only was the incidence of invasive Hib disease very high (in at least some subgroups of Aboriginal and Torres Strait Islander children), it also occurred at a younger age than in non-Indigenous children.² A vaccine to prevent Hib disease in Aboriginal and Torres Strait Islander children needed to be immunogenic when administered early in infancy. For reasons that are not entirely clear the vaccine known by the abbreviation PRP-OMP (PedvaxHIB) is more immunogenic at 2 months of age than the other conjugate Hib vaccines. PRP-OMP was included as the preferred Hib vaccine for Aboriginal and Torres Strait Islander children in the ASVS in 1993. Since then there has been a dramatic decline of Hib disease in Aboriginal and Torres Strait Islander children.³ The experience in other high incidence populations indicates that it is important to continue to use PRP-OMP vaccine in Aboriginal and Torres Strait Islander

children, particularly those in populations demonstrated to be at high risk, as in central and northern Australia (see also Part 3.7, '*Haemophilus influenzae* type b').

- (c) **Invasive pneumococcal disease.** This is up to 10 times more common among some groups of Aboriginal and Torres Strait Islander children than in the non-Indigenous population.^{4,6} In addition, upper and lower respiratory tract disease, which is much more common among Aboriginal and Torres Strait Islander children, is likely to be significantly reduced by the pneumococcal conjugate vaccine, justifying special preventive measures. The recommendations for pneumococcal conjugate vaccine are detailed in Part 3.18, 'Pneumococcal infections.'

- (d) **Meningococcal disease.** Increased rates of meningococcal infection have been reported in Aboriginal and Torres Strait Islander people in Queensland and Western Australia. Data on the serogroup distribution of meningococcal disease among Aboriginal and Torres Strait Islander children are sparse. The potential impact of meningococcal group C conjugate vaccines is therefore unknown, but outbreaks of group C meningococcal disease have been reported in Aboriginal communities in north Queensland⁷ (see also Part 3.14, 'Meningococcal infections').

There have been several well-documented outbreaks of invasive meningococcal disease in Aboriginal and Torres Strait Islander communities. Guidelines for the control of meningococcal disease in Aboriginal and Torres Strait Islander communities have been published elsewhere.⁸

- (e) **Hepatitis B.** Serological surveys carried out before hepatitis B vaccines became widely available indicated that, although there was considerable variation between communities, the prevalence of markers of hepatitis B virus (HBV) infection and HBV carriage was very high in many Aboriginal and Torres Strait Islander communities. A small percentage of Aboriginal and Torres Strait Islander children have a suboptimal response to recombinant hepatitis B vaccine.^{9,10} The cause of this suboptimal response is uncertain. Regardless, there has been a marked decline in the prevalence of markers of HBV infection and carriage in Aboriginal and Torres Strait Islander children since the introduction of hepatitis B vaccine. It has also been shown that the majority of Aboriginal and Torres Strait Islander children who were vaccinated in infancy still have vaccine-induced immunological memory at 5 to 6 years of age, indicating that they do not require a booster dose at school entry. (See also Part 3.9, 'Hepatitis B').
- (f) **Hepatitis A.** Hepatitis A infection has also been shown by serological surveys to occur at a much earlier age among Aboriginal and Torres Strait Islander children.¹¹ Hepatitis A infection, complicated by liver failure and death, has been reported among Indigenous children in far north Queensland.¹² In 1999 an immunisation program for hepatitis A was commenced among children from 18 months of age in north Queensland (see also Part 3.8, 'Hepatitis A').
- (g) **Measles.** The higher burden of disease from measles among Aboriginal and Torres Strait Islander children in the past makes continuing high uptake of measles vaccine particularly important (see also Part 3.13, 'Measles').
- (h) **Oral poliomyelitis vaccine.** Aboriginal children in north Australia (and probably elsewhere) have a suboptimal response to OPV.⁹ This has also been observed in children in developing countries, where it has been attributed to 'a complex array of factors related to the vaccine, host and environment'. It is fortunate that the disease has been eradicated from Australia because there is no simple solution to the suboptimal response. No data are available concerning the response of Aboriginal and Torres Strait Islander infants to inactivated poliovirus vaccine (IPV) but this would be expected to confer adequate immunity (see also Part 3.19, 'Poliomyelitis').

(ii) Adults

Aboriginal and Torres Strait Islander adults experience considerably greater mortality and morbidity from pneumonia and invasive pneumococcal disease than do other Australian adults. In Western Australia, for example, Aboriginal adults aged 25 to 54 years have at least a 30-fold greater risk of hospitalisation from pneumonia than other adults of the same age, an excess risk apparent even among Aboriginal adults living in urban areas.⁴ In central Australia, Aboriginal adults aged 15 to 49 years have a 20-fold greater incidence of invasive pneumococcal disease than non-Indigenous adults of the same age.⁵

The 23-valent pneumococcal polysaccharide vaccine is recommended for all Aboriginal and Torres Strait Islander people aged 50 years and over, and for those aged 15 to 49 years who have high-risk underlying conditions. Annual influenza vaccination is also recommended for Aboriginal and Torres Strait Islander adults aged 50 years and those aged 15 to 49 years who have high-risk underlying conditions (see also Part 3.11, 'Influenza' and Part 3.18, 'Pneumococcal infections').

A study in far north Queensland has demonstrated that the NHMRC recommendations for pneumococcal vaccination are appropriate for Aboriginal and Torres Strait Islander adults, and evaluation has since demonstrated the impact of the pneumococcal immunisation program among this population.¹³

(iii) Other vaccines

The first ever outbreak of Japanese encephalitis (JE) in Australia occurred in the remote outer islands of the Torres Strait in 1995. JE vaccine was first offered to the residents of these islands in late 1995, and since then the vaccine has been integrated into the childhood vaccination schedule commencing at 12 months of age (see also Part 3.12, 'Japanese encephalitis').

Vaccine service delivery for Aboriginal and Torres Strait Islander Australians

Vaccination is a fundamental aspect of primary health care services for Aboriginal and Torres Strait Islander people. The primary goal for childhood vaccination in Australia was that 90% of children should be fully vaccinated by their second birthday by the year 2000, and 95% should be protected against measles. A strong commitment is required for optimal vaccination coverage of Aboriginal and Torres Strait Islander children, particularly those in rural towns or urban settings. There is a need for relevant and appropriate information for the parents of Aboriginal and Torres Strait Islander children, and for high quality training for the service providers, in particular for Aboriginal and Torres Strait Islander Health Workers.

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2.2 VACCINATION FOR INTERNATIONAL TRAVEL

Infections acquired by travellers¹

Common infections acquired by travellers include those which follow ingestion of contaminated food or water. Most of these are diarrhoeal diseases due to enteric pathogens such as enterotoxigenic *Escherichia coli*, *Salmonella*, *Campylobacter*, *Shigella* and *Giardia* species but infections with extra-intestinal manifestations, such as typhoid fever, amoebiasis, poliomyelitis, hepatitis A, brucellosis and cysticercosis are also acquired this way.

Mosquito-borne infections, mostly malaria and dengue, are important causes of fever in Australian travellers returning from southeast Asia, Papua New Guinea, the Solomon Islands and Vanuatu. Japanese encephalitis occurs throughout Asia but the risk to most Australian travellers is low. Yellow fever occurs only in parts of Africa and Central and South America.

Vaccine-preventable infections transmitted via the respiratory tract include diphtheria, pertussis, measles, influenza, and invasive meningococcal disease. Tuberculosis is mostly acquired by expatriates who live in high-risk areas for long periods.

Viral infections transmitted by blood transfusion or contaminated needles, such as hepatitis B, hepatitis C and human immunodeficiency virus (HIV), may pose a threat to some Australian travellers. In remote areas of some countries there is the possibility that these viruses are transmitted by health-care workers using unsterile medical equipment.

Travellers may be exposed to other diseases such as rabies from dog (and other animal) bites in countries such as Thailand, schistosomiasis after swimming in African lakes, cutaneous larva migrans after sunbathing on contaminated beaches, hookworm and strongyloidiasis after walking barefoot on contaminated soil and leptospirosis following rafting or wading in contaminated streams.

Prevention of infections in travellers

Vaccination plays a role in protecting Australian travellers against some of the many infectious diseases that are endemic in other parts of the world. However, vaccination is only one of several important strategies which travellers should adopt to protect their health when abroad. General advice, especially for travellers to developing countries, should include precautions against consuming contaminated food or water. In addition, travellers to countries where mosquitoes are known to transmit infectious diseases should be advised about precautions against mosquito bites, and the need for appropriate malaria chemoprophylaxis should be assessed.

The intending traveller's planned route, season, duration, and style of travel and then his or her medical and vaccination history must all be considered when estimating the risk of acquiring infection while abroad. Not all travellers to countries where there is a potential risk of infection need to be vaccinated or be given malaria prophylaxis. For example, a visitor spending a few days in a major hotel in Bali requires few vaccines and no malaria prophylaxis, while an individual planning to spend many months in African villages may need a range of vaccinations and continuous malaria prophylaxis. Advice should be individualised and addressed to suit 'this traveller, this trip, this time'.

Current information on the hazards of travel can be found in medical journals,² at Internet web sites such as those maintained by the Centers for Disease Control and Prevention (CDC) in the United States

(www.cdc.gov/travel/index.htm) and the World Health Organization in Geneva (www.who.int/ith/), and at medical practices in this country which specialise in travel health. The latter may also dispense vaccines for yellow fever, Japanese encephalitis and rabies. The WHO's comprehensive annual publication, *International Travel and Health*, is available at www.who.int/ith. As recommendations for specific countries change frequently, such sources should be checked on a regular basis.

Vaccines on the Australian Standard Vaccination Schedule (ASVS)

All intending travellers should have been vaccinated according to the recommended vaccination schedule for the traveller's age.

As a result of national campaigns to eliminate measles in children, the epidemiology of measles in Australia has changed. Most measles outbreaks now follow infection imported by inadequately vaccinated young Australian travellers.³ Therefore Australians born during or since 1966 who have not received a second dose of MMR vaccine or a 'catch-up' dose during the 1998 campaign should be vaccinated before travelling.

Travellers to countries where health services are difficult to access should be adequately protected against tetanus prior to departure. They should receive a booster dose of dT if more than 10 years have elapsed since the last dose.

All travellers aged 65 years and over should receive annual influenza vaccine when heading to the northern winter, as should any traveller with a medical risk factor. All travellers aged 65 years and over should also have received 23-valent pneumococcal polysaccharide vaccine. Young adults should be vaccinated against hepatitis B.

Vaccines for prevention of food and water-borne infections

Hepatitis A

Given the frequency of hepatitis A in developing countries, travellers to these countries should be vaccinated against hepatitis A, regardless of duration of travel. Normal human immunoglobulin should no longer be used routinely to prevent hepatitis A in Australian travellers.

Poliomyelitis

Travellers (mostly born outside Australia) who have never been vaccinated against poliomyelitis should be vaccinated using either oral poliomyelitis vaccine (OPV) or the inactivated poliomyelitis vaccine (IPV).

Typhoid and cholera

Typhoid vaccine, either oral or parenteral, should be given to most travellers to high-risk areas. Although an oral cholera vaccine is now available, the efficacy is of relatively short duration. Furthermore, cholera appears to be a very rare cause of infection in returning Australian travellers. Certification of cholera vaccination has been globally abandoned and no countries have official entry requirements for cholera vaccination. Note that oral cholera and typhoid vaccines may be rendered ineffective by the simultaneous use of antibiotics and antimalarial medicines – see also the relevant vaccine chapters.

Vaccines for other diseases

Japanese encephalitis

Vaccination is recommended for travellers spending more than 4 weeks in rural areas of Asia, particularly if travel is during the wet season, and/or there is considerable outdoor activity and/or the standard of accommodation is suboptimal. Vaccination is also recommended for expatriates spending a year or more in Asia (excluding Singapore) even in urban areas (see Part 3.12, 'Japanese encephalitis').

Meningococcal infections

The tetravalent meningococcal polysaccharide vaccine (4vMenPV) is recommended for those who intend travelling to parts of the world where epidemics of meningococcal disease are not infrequent (see Part 3.14, 'Meningococcal infections'). This includes the 'meningitis belt' of sub-Saharan Africa, as well as other areas experiencing epidemics. The Saudi Arabian authorities require that all pilgrims attending the annual Hajj show evidence of vaccination with 4vMenPV.⁴ Young adult travellers who

intend staying more than a month in either Europe or North America should be vaccinated against meningococcal group C disease, using either the conjugate or polysaccharide vaccine.

Rabies

Vaccination is recommended for travellers spending more than 4 weeks in countries where rabies is endemic (see Part 3.2, 'Australian bat lyssavirus infection & rabies') and particularly for those living in rural areas and working with animals.

Tuberculosis

Vaccination is generally recommended for tuberculin-negative children under the age of 5 years who will be living in developing countries for more than 3 months. There is less evidence of the benefit of vaccination in older children and adults, although consideration should be given to vaccination of tuberculin-negative children under 16 years of age who may be living for long periods in high-risk countries (defined as having an incidence ≥ 100 per 100 000 population). See Part 3.25, 'Tuberculosis'.

Yellow fever⁵

Yellow fever vaccination is needed by travellers visiting certain parts of Africa and Central and South America (see Part 3.28, 'Yellow fever'). Vaccination requirements depend on the countries to be visited and the route taken, and may change from time to time, so all travellers are advised to seek current information. Even though a traveller may not be at risk of acquiring yellow fever, vaccination may be necessary in order to comply with national quarantine requirements. The International Health Regulations of the World Health Organization permit countries to demand that its visitors have valid certificates of vaccination against yellow fever and many countries still exercise their right to refuse entry, or to quarantine, visitors who do not carry valid certificates of vaccination against yellow fever.

The vaccine must be administered at an approved yellow fever vaccination centre. Vaccinees should have an International Certificate of Vaccination filled in, signed, and validated with the stamp of the centre where the vaccine is given, and should be sure to carry the certificate when crossing country borders. All persons over one year of age who, within 6 days of arrival in Australia, have been in or have passed through an infected area as listed by the World Health Organization must be in possession of a current valid International Certificate of Vaccination against yellow fever. The validity of a yellow fever vaccination certificate extends for 10 years, commencing 10 days after the date of vaccination, or, in the case of revaccination before expiry of the previous certificate, from the date of that revaccination.

If international travel regulations are the only reason to vaccinate a patient in whom contraindications apply (see 3.28, 'Yellow fever') efforts should be made to obtain a waiver. A physician's letter clearly stating the contraindication(s) to vaccination is acceptable to some governments. Ideally, the letter should be written on letterhead stationery and bear the stamp used by the health authority and official vaccination centres to validate the International Certificates of Vaccination. Under these conditions, it is also essential for the traveller to obtain specific and authoritative advice from the country or countries he or she plans to visit, and their relevant embassies or consulates should be contacted. Subsequent waiver of requirements should be documented by appropriate letters.

Table 2.2.1 provides a summary of some of the commonly used travel vaccines for adults. Please check individual vaccine chapters for specific contraindications and precautions. For children and pregnant women with specific travel vaccination needs, see relevant vaccine-specific chapters. Note that all travellers should also be up to date with other routine vaccinations.

Table 2.2.1: Dose and routes of administration of commonly used travel vaccines in adults

Vaccine (adults)	Brand name	Main constituents	Dose (adults)	Route	Primary schedule	Duration of immunity/booster recommendations
Hepatitis A	Avaxim	160 EIA U inactivated HAV antigen	0.5 mL	IM	0, 6 to 12 months	Although still uncertain, a completed 2-dose series of any hepatitis A vaccine may give life-long immunity.
	Havrix 1440	1440 EIA U inactivated HAV antigen	1 mL	IM	0, 6 to 12 months	
	VAQTA Adult	50 U inactivated HAV antigen	1 mL	IM	0, 6 to 18 months	
Hepatitis A/B combined	Twinnix (720/20)	720 EIA U inactivated HAV antigen and 20 µg recombinant hepatitis B virus surface antigen	1 mL	IM	0, 1, 6 months, or *0, 6 to 12 mths or **0, 7, 21 days, and 12 months	A completed series may give life-long immunity to both hepatitis A and B.
Hepatitis A/typhoid combined	Vivaxim	<i>S. typhi</i> polysaccharide 0.25 mg and 160 EIA inactivated HAV antigen	1 mL combined vaccine	IM	Single dose	A dose of monovalent hepatitis A vaccine given 6-12 months later will provide long-term (possibly life-long) immunity. The duration of protection against typhoid is probably 3 years.
† Influenza	Various	15 µg haemagglutinin of 2 current influenza A and 1 influenza B strains	0.5 mL	SC/IM	Single dose	As different strains circulate from year to year, annual vaccination with appropriate formulation is recommended.
Japanese encephalitis	JE-VAX	Inactivated Japanese encephalitis virus	1 mL	SC	0, 7, 28 days	Single booster dose after 3 years.
Measles-mumps-rubella	MMR-II or Priorix	Live attenuated measles-mumps-rubella vaccine	0.5 mL	IM/SC	Travellers born during or since 1966 who have not received a second dose of MMR vaccine or a 'catch-up' dose during the 1998 campaign should be vaccinated before travelling.	
†† Meningococcal (tetravalent polysaccharide)	Mencevax ACWY	50 µg capsular polysaccharides from <i>N. meningitidis</i> serogroups A, C, W135 & Y	0.5 mL	SC	Single dose	Revaccinate 3-5 yearly if at continuing risk.
	Menomune	50 µg capsular polysaccharides from <i>N. meningitidis</i> serogroups A, C, W135 & Y	0.5 mL	SC	Single dose	Revaccinate 3-5 yearly if at continuing risk.
Rabies (pre-exposure prophylaxis)	Mérieux Inactivated Rabies Vaccine	2.5 IU inactivated rabies virus antigens	1 mL	IM/SC	3 doses on days 0, 7 and 28	If at continued high risk of exposure, measure rabies antibody titres 2-yearly. If reported as inadequate, give booster.

Typhoid	Typh-vax oral	Live attenuated typhoid bacteria	A single capsule	Oral	days 1, 3 and 5 (+/- day 7) ‡	Single booster dose after 3 years if 3-dose series given; after 5 years if a 4-dose series given.
	Typherix	25 µg purified Vi capsular polysaccharide	0.5 mL	IM	Single dose	3 yearly
	Typhim Vi	25 µg purified Vi capsular polysaccharide	0.5 mL	IM	Single dose	3 yearly
Yellow fever	Stamaril	Live attenuated yellow fever virus	0.5 mL	IM/SC	Single dose	10-yearly boosters if at ongoing risk

* This schedule is not recommended if prompt protection against hepatitis B is required.

** This 'rapid' schedule should only be used if there is very limited time until departure to endemic regions.

† Elderly people and those with at-risk medical conditions planning to travel to areas where influenza may be active should be vaccinated with the appropriate vaccine strain for that season.

†† Young adult travellers who intend staying more than a month in either Europe or North America should be vaccinated against meningococcal group C disease, using either the conjugate or polysaccharide vaccine.

‡ A fourth capsule of oral typhoid vaccine on day 7 is recommended for those planning to reside in endemic areas for an extended period, as it confers more prolonged immunity than the 3 capsule regimen.

NB: Routine use of cholera vaccine is not recommended, as the risk to travellers is very low.

IM= intramuscular injection.

SC= subcutaneous injection.

Advising the traveller with special risk factors

Vaccine recommendations may vary for those travellers with altered immunocompetence (including HIV). For pregnant travellers and families with young children who are unable to avoid travel to high-risk areas, advice on vaccination and the need for malaria prophylaxis should be tailored. Each child should be assessed on an individual basis for the need for travel vaccinations, taking any possible contraindications into account (see Table 2.2.2¹). Young children travelling with their families should also be up to date with routine vaccinations included on the standard childhood vaccination schedule. The usual precautions for safe food and water should be taken, as for adults.

Table 2.2.2: Recommended lower age limits of travel vaccines for children

Vaccine	Lower age limit	Dose/route	Primary schedule	Comments
Hepatitis A				
Avaxim	2 years	0.5 mL IM	0, 6 to 12 months	Recommended for travel to developing countries.
Havrix Junior	2 years	0.5 mL IM	0, 6 to 12 months	
VAQTA paediatric/adolescent	2 years	0.5 mL IM	0, 6 to 18 months	
Hepatitis A/B				
Twinrix Junior (360/10)	1 year	0.5 mL IM	0, 1, 6 months	Recommended for travel to developing countries.
Twinrix (720/20)	1 year	1.0 mL IM	0, 6 to 12 months	
Japanese encephalitis				
JE-VAX	1 year	1–3 years of age: 0.5 mL SC over 3 years of age - 1.0 mL SC	0, 7, 28 days 0, 7, 28 days	Only for travellers spending more than 4 weeks in high-risk rural areas, or those staying in urban areas of Asia (except Singapore) for more than one year.

Typhoid				
Typh-vax oral (oral live vaccine)	6 years	oral capsule	One capsule on days 1, 3 and 5	Recommended for travel to developing countries. Do not give live oral vaccine with antibiotics, sulphonamides or proguanil.
Typhex or Typhim Vi (injectable killed)	2 years	0.5 mL IM	Single dose	
Yellow fever				
Stamaril	9 months	0.5 mL IM/SC	Single dose	Yellow fever vaccine should not be given to infants aged under 9 months due to the risk of encephalitis.

IM= intramuscular injection

SC= subcutaneous injection

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2.3 GROUPS WITH SPECIAL VACCINATION REQUIREMENTS

This chapter considers the use of current vaccines in people who have special vaccination requirements, those who may experience more frequent adverse events, and those who may have a suboptimal response to vaccination. Recommendations for immunisation of those at occupational risk are also included.

Children who have had a serious adverse event following immunisation

Children who have had a serious adverse event (other than a contraindication, such as anaphylaxis) to a vaccine may be subsequently vaccinated under close medical supervision.

Vaccination during pregnancy

Although the use of many vaccines during pregnancy is not usually recommended on theoretical grounds, there is no convincing evidence that pregnancy should be an absolute contraindication to the use of standard vaccines. With the exception of vaccinia virus (smallpox vaccination), the vaccines described in this *Handbook* have not been shown to cause fetal malformation. There is some evidence, however, that fever *per se* is teratogenic^{1,2} so that vaccination in early pregnancy should usually be deferred. With the exception of the use of influenza vaccine, the NHMRC takes the conservative position that the use of vaccines during pregnancy should generally be avoided at any stage of the pregnancy, since definitive studies on the level of risk have not been carried out. Live vaccines should be avoided unless the risk of disease is greater than the risk of the vaccine (see also Part 3.11, 'Influenza').

However, if a pregnant woman is likely to be at significant risk of an infection that can be prevented by vaccination, then the vaccine should be used. Conversely, if the risk of infection from a particular disease is not immediate and significant, then the relevant vaccine should not be used, or its use should be postponed until after the pregnancy. In some cases, changing travel plans can eliminate the risk of exposure (and the need for vaccination).

Hepatitis B

Pregnancy should not be considered a contraindication to the use of this vaccine in persons for whom it would otherwise be indicated.

Immunoglobulins

There is no known risk to the fetus from passive immunisation of pregnant women with immunoglobulins.

Influenza

Influenza vaccine is considered safe and is recommended for pregnant women who either have a risk factor for the complications of influenza, or will be in the second or third trimester during the influenza season (see also Part 3.11, 'Influenza').

MMR or rubella vaccine

Despite concerns that attenuated rubella vaccine virus might cause congenital abnormalities, rubella vaccine (either monovalent or as MMR) has been given to pregnant women (usually inadvertently) without harm to the fetus. Even though the rubella vaccine virus can infect the fetus³ if given in early pregnancy, there is no evidence that it causes congenital rubella syndrome in infants born to susceptible mothers vaccinated during pregnancy, and rubella vaccination during pregnancy is not an indication for termination. It is standard practice to test all pregnant women for immunity to rubella, and to vaccinate (preferably using MMR) susceptible women as soon as possible after delivery. Women of child-bearing age should avoid becoming pregnant for 28 days after rubella vaccination (see also Part 3.22, 'Rubella').

Poliomyelitis vaccine

Pregnant women who are at substantial risk of exposure to poliomyelitis can be given OPV. An alternative is to give IPV, if the series of injections can be completed before the anticipated exposure (see also Part 3.19, 'Poliomyelitis').

Yellow fever vaccine

Pregnant women who must travel to an area where there is a risk of yellow fever should receive yellow fever vaccine (see also Part 3.28, 'Yellow fever').

Varicella-zoster vaccine

Varicella-zoster vaccine should not be administered during pregnancy, and women of child-bearing age should avoid becoming pregnant for one month after vaccination. However, the fact that congenital varicella syndrome has (to date) not been identified in women who have been accidentally vaccinated in early pregnancy provides some reassurance of the safety of the vaccine.⁴

Contact between pregnant women and individuals who have recently received live virus vaccines

Although individuals vaccinated with OPV, and on very rare occasion individuals vaccinated with varicella-zoster vaccine, can shed live virus, there is no evidence that there is any risk to the fetus if pregnant women are in contact with recently vaccinated individuals. Therefore it is safe to administer varicella-zoster vaccine to household contacts of non-immune pregnant women. MMR vaccine viruses are not transmissible.

Breastfeeding and vaccination

The rubella vaccine virus may be secreted in human breast milk and transmitted to breastfed infants but where infection has occurred in an infant it has been mild. Otherwise there is no evidence of risk to the breastfeeding baby if the mother is vaccinated with any of the live or inactivated vaccines described in this *Handbook*. Breastfeeding does not adversely affect immunisation and is not a contraindication for the administration of any vaccine to the baby.

Preterm babies⁵⁻⁷

Despite their immunological immaturity, preterm babies should be vaccinated according to the recommended schedule at the usual chronological age, provided that they are well and that there are no contraindications to vaccination. OPV, which might spread the live vaccine virus to other babies in the hospital, should not be given until the time of discharge. Alternatively, IPV (inactivated polio vaccine) can be used.

Preterm infants have a special need for protection and they have adequate antibody responses to most antigens. However, some smaller preterm babies do not respond as well as term babies to PRP-OMP

Hib (PedvaxHIB) and hepatitis B vaccines⁸⁻¹³ When PedvaxHIB is used in an extremely preterm baby (<28 weeks gestation or <1500 g birth weight), an additional dose of vaccine should be given at 6 months of age (ie. doses should be given at 2, 4, 6 and 12 months of age). Recommendations for hepatitis B vaccination of babies less than 32 weeks' gestation are described in Part 3.9, 'Hepatitis B', page 96.

All preterm babies born at less than 28 weeks' gestation or with chronic lung disease should be offered the 7-valent pneumococcal conjugate vaccine at 2, 4 and 6 months of age with a fourth dose at 12 months of age, and a 23-valent pneumococcal polysaccharide vaccine booster at 4 to 5 years of age (see also Part 3.18, 'Pneumococcal infections').

Vaccination for those at increased risk of infection

Medical conditions that increase the risk from infectious diseases, even in the absence of specific immune defects, demand special attention to the use of current vaccines. This includes the use of influenza vaccine in severe asthma, chronic lung disease, congenital heart disease and Down's syndrome; pneumococcal conjugate vaccine in children with renal failure, persistent nephrotic syndrome and certain anatomical abnormalities; and pneumococcal polysaccharide vaccine in adults with certain chronic medical conditions. See the appropriate chapters for current recommendations.

Vaccination of individuals with impaired immunity due to disease or treatment¹⁴⁻¹⁶

The vaccination of individuals with impaired immune systems presents several problems. First, the immune response to vaccines may be inadequate and, second, there is a risk that some live vaccines may themselves cause progressive infection. Degrees of immunodeficiency vary from insignificant to profound and this should be taken into account when considering a schedule of vaccination, as should the risk of acquisition of the infection one is trying to prevent. Although it may be logical to give higher or more frequent doses of vaccines to these patients, in many cases there are insufficient data to advocate such measures. Because of the uncertainty of the immune response in some immunodeficient patients, it may be useful to measure post-vaccination antibody titres in groups such as children who have received haemopoietic stem cell transplants (see below).

Live vaccines such as OPV, MMR and varicella-zoster must *not* be given to severely immunocompromised patients. OPV must *not* be given to either the siblings or other household contacts of immunocompromised patients; IPV must be used instead.

Live viral and bacterial vaccines

Although most live vaccines are contraindicated in significantly immunodeficient patients, the risk of progressive infection varies. The following is a list of current recommendations:

- Vaccines for smallpox (vaccinia virus) and tuberculosis (BCG) are always contraindicated.
- Oral poliomyelitis vaccine should not be given to the patient or to the patient's parents or siblings. Use inactivated poliomyelitis vaccine (IPV) instead.
- Immunodeficient travellers should not be given live oral cholera or typhoid vaccines. Use Vi polysaccharide typhoid vaccine instead.
- Yellow fever vaccine is only indicated if the patient must travel to an area where there is a high risk of yellow fever. Most immunodeficient patients should obtain waivers of vaccination ratified by health authorities and immigration departments where international vaccination requirements are the only reason to vaccinate.
- Measles, mumps, rubella (MMR) and varicella-zoster vaccines may be given to mildly immunodeficient children with HIV infection (see below).

Contacts of immunodeficient patients

Healthy siblings and close contacts of immunodeficient children should be vaccinated with MMR and varicella-zoster vaccines to prevent them from infecting their immunodeficient sibling. There is no risk of transmission of the MMR vaccine viruses and there is an almost negligible risk of transmission of

varicella-zoster vaccine virus (see Part 3.27, 'Varicella-zoster'). These close contacts should be given IPV and not OPV when being given routinely scheduled vaccines.

Influenza and invasive pneumococcal disease

Morbidity and mortality from two vaccine preventable infections, namely influenza and invasive pneumococcal disease, are increased in all significantly immunodeficient patients. Annual influenza vaccination should be given to all immunodeficient patients.

Immunodeficient patients should also receive either the 7-valent pneumococcal conjugate vaccine (7vPCV), or 23-valent pneumococcal polysaccharide vaccine (23vPPV), depending on their age (see Part 3.18, 'Pneumococcal infections'). Although the immune response to 23vPPV may be suboptimal in those who most need protection, the vaccine is nevertheless strongly recommended for these individuals.

While it may seem logical to give 7vPCV followed by 23vPPV to immunodeficient adults, studies evaluating the efficacy of such a regimen have not yet been published.

Corticosteroid administration

In adults daily doses of oral corticosteroids in excess of 60 mg of prednisolone (or equivalent), and in children doses in excess of either 2mg/kg per day for more than a week or 1 mg/kg per day for more than 4 weeks, are associated with significant immunodeficiency. However, even lower doses may be associated with some impairment of immune response.

For adults treated with systemic corticosteroids in excess of 60 mg per day, live vaccines (such as MMR, OPV, varicella-zoster and BCG) should be postponed until at least 3 months after treatment has stopped. Children on lower daily doses of 2 mg/kg per day of systemic corticosteroids for less than 2 weeks, and those on lower doses of 1 mg/kg per day or alternate-day regimens for longer periods, may be given live virus vaccines.

Widespread use of potent topical steroids, particularly when used in conjunction with occlusive dressings, for more than 2 weeks may give rise to significant immunodeficiency. The use of inhaled steroids is *not* a contraindication to the use of live vaccines.

Oncology & organ transplant patients¹⁷⁻²⁰

During chemotherapy, and for 6 months afterwards, patients may receive inactivated vaccines (eg. DTPa, Hib, hepatitis B, IPV) according to the normal schedule of vaccination but it should be remembered that patients are unlikely to mount a full immune response while they are on therapy. Care should also be given to ensuring the patient is not vaccinated with any vaccine during times of severe neutropenia, to avoid precipitating acute febrile neutrophilia response following vaccination.

If the patient is well and infection free 6 months after chemotherapy, and there are no clinical concerns about the immune status, the following schedule of revaccination is recommended; DTPa if less than 8 years (dT or adult/adolescent formulation dTPa if >8 years), MMR, IPV, Hib (if less than 5 years old or with prior splenectomy/hyposplenism) and hepatitis B. These vaccines may be given without checking antibody titres beforehand, and may be given together on one day. Measles and rubella antibody status should be checked 6 to 8 weeks after vaccination. Patients who have not seroconverted should receive a further dose of MMR. IPV may be repeated 12 months later. Although varicella-zoster vaccines are contraindicated in patients undergoing immunosuppression, they may be used after completion of therapy. It is recommended that children be vaccinated 3 months after high dose steroid therapy has ceased.

Any deviations from these guidelines should be discussed with an oncologist.

Revaccination following blood or bone marrow stem cell transplantation (BMT)²¹⁻²⁵

Protective immunity to vaccine preventable diseases is partially or completely lost following either allogeneic or autologous stem cell transplantation. Immunodeficiency induced by allogeneic transplantation is more prolonged and more severe, especially in patients who develop a phase of chronic graft versus host disease (GVHD). Systematic reimmunisation is necessary but practices vary widely amongst transplant units. Titres of antibodies to measles, mumps and rubella, as well as

Haemophilus influenzae type b, polioviruses, diphtheria and tetanus antitoxins, if available, should be checked routinely in BMT patients, before and after vaccination. Inactivated vaccines may be given as early as 6 months after BMT, so long as the patient has been off post-BMT immunosuppression for at least 3 months (ie. 6 months after BMT for autologous BMT, 8 to 9 months after BMT for allogeneic BMT).

Paediatric oncology and bone marrow transplant units should have written protocols for the vaccination of their patients. Suitable schedules have been written by the European Group for Blood and Marrow Transplantation²³ and a Working Group convened by the Centers for Disease Control and Prevention.²⁴ This document is available on the CDC's web server www.cdc.gov/mmwr/PDF/rr/rr4910.pdf

Vaccination should be deferred for patients with chronic GVHD or in patients still receiving intravenous immunoglobulin.

HIV-infected individuals

Vaccination schedules for HIV-infected patients should be determined by the patient's age, degree of immunodeficiency (CD4 count) and the risk of infection. Children with perinatally acquired HIV differ substantially from adults as immunisation and first exposure to vaccine antigens occurs after HIV infection, whereas for adults most vaccines are inducing a secondary immune response.²⁶ HIV-infected individuals of any age who are well controlled on combination antiretroviral therapy (undetected or low viral load with good preservation of CD4 lymphocyte count) are likely to respond well to vaccines.

HIV-infected patients should be vaccinated as follows:

- Diphtheria-tetanus-pertussis (DTPa/dTpa) and Hib vaccines – use the standard schedule;²⁷
- Poliomyelitis vaccines – OPV has not proved harmful to asymptomatic HIV-infected children, nevertheless, IPV is preferred.
- MMR vaccine – unless they are severely immunodeficient, MMR should be routinely administered to HIV-infected children at 12 months of age. Table 2.3.1 shows age-specific definitions of severe immunodeficiency. Measles may cause severe disease in HIV-infected children and severely immunodeficient children who are exposed to measles should therefore be given normal immunoglobulin (in a dose of 0.5 mL/kg), regardless of their vaccination status.²⁴
- While varicella-zoster vaccine is contraindicated in adults with HIV, its use may be considered for asymptomatic or mildly affected children.²⁸ The Advisory Committee on Immunization Practice (ACIP) recommends use of the vaccine, given in 2 doses, 3 months apart, in children with age-specific CD4 T-lymphocyte percentages greater than 25%.²⁹

Table 2.3.1: Age-specific CD4 counts indicating severe immunodeficiency in HIV infection

Age	<12months	1-5 years	≥6Years
CD4 count	<750	<500	<200
	($0.75 \times 10^9/L$)	($0.50 \times 10^9/L$)	($0.20 \times 10^9/L$)

- Pneumococcal vaccine – pneumococcal disease, both respiratory and invasive, is a frequent cause of morbidity in HIV-infected children and adults, and vaccination is recommended for all HIV infected patients, despite limited evidence of efficacy. Infants and young children should be vaccinated with the pneumococcal conjugate vaccine. Older children and adults should be vaccinated with the polysaccharide vaccine^{30,31} (see also Part 3.18, 'Pneumococcal infections').
- Influenza vaccine – because of its established efficacy in reducing morbidity, annual vaccination is advisable even in symptomatic HIV-infected adults and children.^{32,34} Viral loads may increase after vaccination but CD4 counts are unaffected and the benefits exceed the risk.³⁵⁻³⁸
- Hepatitis B vaccine – recombinant hepatitis B vaccines are safe to use, but the immunological response may be poor. HIV-positive individuals should receive twice the normal dose (ie. double the normal volume of vaccine on 3 occasions or a standard dose of the increased strength dialysis formulation of vaccine on 3 occasions). Antibody level should be measured at the completion of the vaccination schedule. The indications for use of hepatitis B vaccine are the same as for non-HIV-infected individuals. Because many HIV-positive men who have sex with men may already

have been exposed to the hepatitis B and hepatitis A viruses, their susceptibility should be determined in order to avoid unnecessary vaccination.

- Hepatitis A vaccine – susceptible HIV-infected individuals should be vaccinated.
- BCG vaccine – BCG must *not* be given to HIV-infected children or adults because of the risk of disseminated BCG infection.
- Vaccinations for travel – live attenuated typhoid and live cholera vaccines should not be given to HIV-infected individuals. Vi polysaccharide typhoid, Japanese encephalitis and rabies vaccines are safe and can be used for the usual indications (see Part 2.2, ‘Vaccination for international travel’).

Individuals with functional or anatomical asplenia^{39,40}

(i) Individuals with an absent or dysfunctional spleen are at increased risk of fulminant bacteraemia, most notably pneumococcal, for the rest of their lives.⁴¹

(ii) All splenectomised adult individuals should receive the pneumococcal polysaccharide vaccine. There are limited data on the value of revaccination but it is appropriate to administer a further dose 5 years after the first dose. *Haemophilus influenzae* type b (Hib) vaccination is recommended for splenectomised adults who have close contact with children less than 5 years of age.

(iii) In elective splenectomy the vaccination should be given 2 weeks before the operation; in unplanned splenectomy, vaccination should be given when the patient has recovered from surgery.⁴²

(iv) Children <5 years of age with splenic dysfunction, most frequently due to sickle cell disease, should be vaccinated with pneumococcal conjugate vaccine (see Part 3.18, ‘Pneumococcal infections’). To further reduce the risk of pneumococcal disease, they should also be treated with daily prophylactic doses of penicillin V, commencing before the age of 4 months (penicillin V 125 mg twice daily, rising to 250 mg twice daily when they reach 4 years of age, until 5 years of age).

(v) All splenectomised individuals should be vaccinated first with a single dose of meningococcal C conjugate vaccine, followed 2 or more weeks later by a single dose of the tetravalent meningococcal polysaccharide vaccine (see also Part 3.14, ‘Meningococcal infections’).

Vaccination of recent recipients of normal human immunoglobulin

The immune response to live viral vaccines (with the exception of yellow fever vaccine) may be inhibited by normal human immunoglobulin. In general, live virus vaccines should be given 3 weeks before or 3 months after a dose of immunoglobulin. However, specialist advice should be sought if high-dose or intravenous immunoglobulins have been used.

Vaccination of patients with autoimmune diseases

Adults with conditions such as systemic lupus erythematosus,^{43,44} rheumatoid arthritis⁴⁴ and multiple sclerosis⁴⁵ should be given influenza and pneumococcal polysaccharide vaccines. There is clear evidence that influenza vaccination is not associated with an increased risk of exacerbations of multiple sclerosis, and either insufficient or no evidence that other vaccines increase the risk.⁴⁶

Vaccination of patients with bleeding disorders

Intramuscular injection may lead to haematoma formation in patients with disorders of haemostasis and to pressure necrosis, muscle contractures or nerve compression in patients with severe coagulopathies. Children with inherited coagulopathies should receive factor replacement prior to intramuscular injection. Unless warfarin doses are known to be stable, patients receiving this anticoagulant should have prothrombin times measured before intramuscular injections, which should be deferred if the INR (international normalised ratio) is greater than 3.0. Patients with platelet counts of less than 50 X 10⁹/L should not receive intramuscular injections.

The subcutaneous route should be considered as an alternative to the intramuscular route in patients with bleeding disorders.⁴⁷

Vaccination of those at occupational risk

Certain occupations, particularly those associated with health care, are associated with an increased risk of some vaccine preventable diseases.^{48,49} Furthermore, health care workers may transmit infections such as influenza, rubella, and pertussis to susceptible patients. Current recommendations for hazardous Australian occupations are listed in Table 2.3.2.

Medical facilities or health departments are encouraged to formulate a comprehensive immunisation policy for all health-care workers. Each worker should be individually assessed for specific vaccines, taking possible contraindications into account.

Work practices should include the use of standard precautions to minimise exposure to blood and body fluids. If exposure does occur, guidelines for post-exposure prophylaxis should be followed.

Table 2.3.2: Recommended vaccinations for those at risk of occupationally-acquired vaccine preventable diseases (see also relevant individual disease chapters).

Disease/vaccine	Health-care workers (HCWs)*	Other occupations
Hepatitis B	<ul style="list-style-type: none"> All HCWs directly involved in patient care, embalming or the handling of human blood or tissues 	<ul style="list-style-type: none"> Police, members of the armed forces and emergency services, depending upon the duties to which they are assigned Carers of the intellectually disabled Staff of correctional services facilities
Hepatitis A	<ul style="list-style-type: none"> HCWs who frequently attend paediatric patients from rural and remote Indigenous communities HCWs who work with rural and remote Indigenous communities. 	<ul style="list-style-type: none"> Other workers who live with, or make frequent visits to, remote Indigenous communities Sewerage workers Child-care and pre-school staff Carers of the intellectually disabled
Influenza	<ul style="list-style-type: none"> All HCWs Staff of nursing homes and long term care facilities 	<ul style="list-style-type: none"> Providers of home care to persons at risk of high influenza morbidity
Measles-mumps-rubella †	<ul style="list-style-type: none"> HCWs born during or since 1966 	<ul style="list-style-type: none"> Child-care staff (born during or since 1966)
Varicella	<ul style="list-style-type: none"> All seronegative health-care workers directly involved in patient care 	<ul style="list-style-type: none"> Seronegative child-care staff and primary school teachers
Pertussis (using dTpa)	<ul style="list-style-type: none"> HCWs in paediatric and maternity departments 	<ul style="list-style-type: none"> Child-care staff
Tuberculosis	<ul style="list-style-type: none"> As recommended by the State/Territory TB control authorities 	<ul style="list-style-type: none"> Check with State/Territory TB control authorities
Q fever	<ul style="list-style-type: none"> Laboratory personnel handling veterinary specimens 	<ul style="list-style-type: none"> Abattoir workers and contract workers in abattoirs Truck drivers transporting livestock to abattoirs Veterinarians Sheep shearers and sheep, cattle and dairy farmers Persons culling/processing kangaroos Tanning and hide workers
Australian bat lyssavirus (ABL) and rabies	<ul style="list-style-type: none"> Laboratory personnel handling either bat tissues or ABL or rabies virus 	<ul style="list-style-type: none"> Those who come into regular contact with bats (both flying foxes and microbats), including bat-handlers, wildlife officers and veterinarians.
Anthrax, plague, poxviruses, typhoid, yellow fever, meningococcal disease	<ul style="list-style-type: none"> Laboratory personnel working with these infectious agents on a routine basis 	

Japanese encephalitis	▪ HCWs assigned to the outer Torres Strait Islands for a month or more during the wet season	▪ Other workers assigned to the outer Torres Strait Islands for a month or more during the wet season
	Laboratory personnel working with this infectious agent	

*Work activities, rather than job title, should be considered on an individual basis to ensure an appropriate level of protection is afforded to each HCW.

†All adults born during or since 1966 should have evidence of receiving 2 doses of MMR vaccine.

Vaccination of immigrants to Australia

Immigrants or refugees may be incompletely vaccinated or have unsatisfactory records of vaccination. Immunisation status is not routinely assessed in children and adults entering Australia as refugees or immigrants.

- If an immigrant child has no valid documentation of vaccination, the standard 'catch-up' schedule should be commenced. If the child is 12 months of age or older, the first doses of DTPa, hepatitis-B, OPV or IPV, MMR and Hib vaccine can be given at the same visit. For details see Part 1.9, 'Catch-up vaccination'.
- If there is a valid record of vaccination, the history of prior doses should be taken into account when planning a catch-up vaccination series.
- Immigrant adults need to be targeted for vaccination against rubella using MMR. This is particularly important for women of child-bearing age.
- IPV (inactivated poliomyelitis vaccine) is preferred over OPV (oral poliomyelitis vaccine) for immunisation of adults who have no history of immunisation against polio. This is to minimise the risk of VAPP (vaccine-associated paralytic poliomyelitis).

Inmates of correctional facilities

Because inmates of correctional facilities are at risk of acquiring hepatitis A and B, they should be vaccinated against these infections.

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