Chapter 25
Australia, New Zealand

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Australia
New Zealand

Australia has both temperate areas in the southern and coastal regions and tropical areas in central and northern Australia. The New Zealand climate, however, is temperate in the main. Temperate Australia and New Zealand (NZ) have similar health services and diseases, with the risks of most common community illnesses (e.g. gastroenteritis, respiratory viruses) being similar to those in other developed countries globally. However, a number of diseases found in temperate Australia have never been reported from NZ, including Ross River virus, Murray Valley encephalitis, Barmah Forest virus, Q-fever, tick typhus, scrub typhus, Hendra virus, lyssavirus and *Mycobacterium ulcerans*. The tropical areas of Australia are sparsely populated, have relatively basic medical services outside major cities and urban areas, and have different disease patterns. Infections such as S*trongyloides stercoralis*, HTLV-1, rheumatic fever, trachoma, melioidosis, and scabies are not infrequent among Australian Aborigines.

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Bacterial and mycobacterial infections

Brucellosis (due to *Brucella suis*) is uncommon and occurs almost exclusively in association with hunting feral pigs. The 2014 notification rate in Australia was 0.1/100 000 population with virtually all infections acquired in rural areas of Queensland followed by northern New South Wales (NSW) [1,2].

Melioidosis, caused by *Burkholderia pseudomallei*, is endemic in northern Australia (Northern Territory, Far North Queensland, Western Australia) and the Torres Strait Islands. Melioidosis is the most common cause of fatal community-acquired pneumonia in Darwin. In the top end of the Northern Territory, cases most frequently occur during the summer monsoonal wet season (November through April) [3–5].

Bartonellosis (cat scratch disease, caused by *Bartonella henselae*) is widespread throughout Australia and NZ. It is associated with bites/scratches from domestic cats.

The overall prevalence of tuberculosis in Australia (5.7 cases per 100 000 population in 2014) and New Zealand (6.6 cases per 100 000 population in 2014) is low [1,2]. *M. tuberculosis* strains are usually sensitive to all major antituberculosis agents.

Mycobacteria ulcerans occurs almost entirely in south-eastern Australia, especially in Victoria (Bairnsdale, Phillip Island, Bellarine, and Mornington Peninsulas). The annual number of cases in Victoria is increasing, although the overall rate of infection is low (1.1/100 000 per year) [6]. The infection has also been reported in Cairns in Far North Queensland, although residents of Cairns are only at risk if they visit the coastal strip north of Cairns between Mossman and just north of the Daintree river. Infections often occur in clusters, but the exact mode of *M. ulcerans* transmission is unknown, but the risk to travelers is low.

Rickettsial infections have been reported from all states of Australia and occur in travelers to rural, forested, and coastal areas [7]. Infections are divided into the spotted fever group spread by ticks and the typhus group spread by fleas from mice and rats.

- *Spotted fever group:* Queensland tick typhus is caused by *Rickettsia australis* and has been reported from Queensland, New South Wales, coastal areas of eastern Victoria and Tasmania. Flinders Island spotted fever, caused by *Rickettsia honei*, has been reported from Flinders Island in southern Australia, Tasmania, and south-eastern Australia.
- *Typhus group:* murine typhus, caused by *Rickettsia typhi*, is present throughout Australia but predominantly in Queensland and Western Australia. Scrub typhus, caused by *Orientia tsutsugamushi*, occurs through coastal northern Queensland (north of Townsville), and tropical northern Australia, including the top end of the Northern Territory (in particular, Litchfield Park south of Darwin) and the Kimberley region of Western Australia. *Rickettsia felis* is present in Western Australia. In NZ, infection has occurred almost exclusively in people living in a rural environment, usually in the warmer climes of the Waikato and Auckland regions [8].

In Australia, the epidemiology of meningococcal disease follows the pattern seen in most other industrialized nations [9]. In 2000, the incidence of notified meningococcal disease reached 3.3 per 100 000, and the incidence of serogroup C disease was around 1.1 per 100 000 in the years prior to 2003 when the vaccine was introduced [10]. Disease incidence has declined markedly since the introduction of the meningococcal C conjugate vaccine, and the incidence of invasive meningococcal infections in Australia in 2014 was 0.7/100 000 population [1]. The case fatality rate is approximately 4%. In contrast, NZ had high rates of meningococcal disease during the 1990s due to the emergence of a serogroup B clone, which by 2000 accounted for 85% of cases. Cases were disproportionately seen among Maori and Pacific Islands children in the North Island of NZ, and infants <1 year had an age-specific rate of 124/100 000 in 2003 [11]. This led to the development of a strain-specific vaccine, MeNZBTM, and a vaccination program between 2004 and 2008 that significantly reduced the rate of meningococcal disease to 1.9/100 000 in 2012, the lowest rate in 20 years: 63% type B and 34% type C, Maori and Pacific Islanders still with significant though lower numbers [12].

Although overall rates of acute rheumatic fever (ARF) in Australia and NZ are low, the rates of ARF among indigenous people are among the highest in the world [13,14]. The average annual incidence

rate of confirmed ARF in Australia between 1996 and 2010 was 26/100000 population. However, the incidence is substantially higher in Aboriginal and Torres Strait Islanders in the top end of the Northern Territory, especially among those aged 5–14 years who account for 58% of all notifications [15]. In New Zealand, the incidence among Maoris is 8 per 100000, 10 times higher than occurs among people of European descent [13].

Leptospirosis occurs in all parts of Australia, mainly as an occupational disease among livestock and agricultural workers. Most cases (>70%) occur in Queensland, with serovars *zanoni*, *australis*, and *hardjo* accounting for most of the disease. Since 1999 in Australia there has been a downward trend in notifications of leptospirosis [16], which has been attributed to recent persistent drought conditions. The incidence of leptospirosis in Australia in 2014 was reported at 0.4/100000 population, with the highest rate reported in Queensland (1.2/100000 population) [1].In NZ, the incidence of the disease is reported as 2.2 per 100000 population, with the most common serovars causing human infection in NZ being *L. borgpetersonii* sv.*hardjo* and *ballum*, and *L. interrogans* sv. *Pomona* [8,16,17].

Although not previously thought to be endemic in Australia, two cases of tularemia caused by *Francisella tularensis* subspecies *holarctica* were reported in 2011 in Tasmania associated with bites from ringtail possums [18].

Viral infections

Australia and NZ have relatively small HIV epidemics. The adult HIV prevalence in the general population in these countries is about 0.2% [19]. Transmission is primarily through sexual contact between men.

Australia is the only country in the world that has reported cases of Hendra virus. The natural reservoir for the Hendra virus is the fruit bat. It can be transmitted to horses and has occasionally been reported among horses in Queensland and New South Wales. Illness has occurred in humans working with infected horses, mostly among veterinarians, leading to either an acute respiratory illness or a meningoencephalitis. The risk to travellers is extremely low.

Dengue virus is not endemic in Australia, but the presence of mosquito vectors in northern Australia has resulted in epidemics following the introduction of dengue virus by travelers returning from other endemic countries. Outbreaks of dengue fever are periodically reported from northern Queensland in the region extending from the Torres Strait south to Cairns, Townsville, and Charters Towers [19]. A major dengue outbreak occurred in the northern suburbs of Cairns between December 2008 and May 2009, with 1026 cases reported in 2009 [19]. Cases were also reported from Townsville, Port Douglas, Yarrabah, Injinoo, and Innisfail. In the rest of the country, dengue fever is predominantly a disease of returned travelers. In 2014 the Australian notification rate was 7.3/100000 population [19].

Ross River virus (RRV) is the most common arboviral disease in Australia and is characterized by fever, rash, and arthralgias. RRV has become established in most parts of Australia and has resulted in several outbreaks [20]. In May 2010, a fourfold increase in the number of RRV cases was reported from the Riverina Murray region in New South Wales, due to greater rain and a larger number of mosquitoes. The incidence of RRV disease in Australia in 2014 was 22.7/100000 [1], although this varied widely according to season and geographical regions (e.g. Queensland 24–146 cases/100000/year; Northern Territory 32–208 cases/100000/year) [19]. An outbreak occurred in Queensland and New South Wales in 2015, with record numbers of cases reported (>7000) in the first six months of the year [19].

Barmah Forest virus (BFV) is a closely related arbovirus that is spread by the same mosquito vectors and hence epidemics of mixed RRV and BFV infections have been reported. BFV is less common with an annual notification rate of about 6.5 (3.2–18.3)/100000/year [19]. The incidence of BFV in the Northern Territory varies from to 12.3 to 167/100000/year, in Queensland from 10 to 47.8/100000/year, and in NSW from 2.2 to 9.4/100000/year [19]. BFV also occurs in Western Australia (including the Kimberley, Pilbara, and Gascoyne regions). Incidence peaks between the months of February to May.

Murray Valley encephalitis (MVE) is an infrequent disease. Over the last decade, cases have been reported from the Northern Territory (South Australia, north-west Western Australia, outback Queensland, and outback NSW). Usually only one or two cases are reported annually, but in 2011 there were 16 cases [20], three-quarters of which were in Western Australia [1], associated with heavy rainfall and flooding [21]. The risk period is maximal from February to early April in central Australia but can persist until June.

Kunjin virus infection is uncommon and only sporadic cases have been reported from Northern Territory, Western Australia, and QLD. The Australian notification rate is <0.1/100 000 population [1].

Japanese encephalitis (JE) is not endemic either on mainland Australia or in NZ but 11 cases have been notified since 2000 [1]. Four of these were reported from Badu Island in the Torres Strait. One locally acquired case was reported in a resident of the Cape York Peninsula of Far North Queensland. The remaining cases were reported in travelers who had acquired infection overseas [20].

Australia and NZ are rabies free, but the Australian bat lyssavirus (ABL) has been isolated from insectivorous and fruit-eating bats in NSW, Northern Territory, Queensland, Victoria, and Western Australia, and has caused three human fatalities. Potential exposure is most likely among professional bat handlers although inadvertent exposure following handling of bats by individuals in the general community has also been reported. There has been one case of ABL over the last 10 years [1,22].

Parasite infections

Infection with the dog hookworm, *Ancylostoma caninum*, has a worldwide distribution but so far the only reports of it also causing an eosinophilic infiltration of the gut wall have been from Australia, mainly from Northern Queensland [23].

Cases of *Angiostrongylus cantonensis*, the rat lungworm, have been reported from Australia, particularly from Queensland and New South Wales [24]. It is acquired by eating contaminated leafy vegetables (in salads), infected snails and slugs (often inadvertently), and land crabs. Symptoms include paraesthesia and an eosinophilic meningitis.

High rates of *Strongyloides stercoralis* are found in some indigenous communities in central Australia. Complicated strongyloidiasis often occurs in association with HTLV-1 infection as these two infections are co-endemic [23].

Australia and NZ are free of endemic malaria and human schistosomiasis.

In addition to infectious outcomes listed in the tables below, travelers also need to be aware of the risks of toxins, envenomations, and bites (spiders and snakes).

CNS infections: meningitis, encephalitis, and other infections with neurological symptoms

Acute infections with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms	Very rare microorganisms
Viral meningitis (enterovirus group)	*Listeria monocytogenes*	*Naegleria fowleri* and other free-living amebae including *Acanthamoeba* spp. and *Balamuthia mandrillaris*
Streptococcus pneumoniae (meningitis)	*Treponema pallidum* (neurosyphilis)	Influenza

Frequently found microorganisms	Rare microorganisms	Very rare microorganisms
Herpes virus (group I and II) *Neisseria meningitides*	HIV Murray Valley encephalitis	*Brucella suis* *Burkholderia pseudomallei* Hendra virus Australian bat lyssavirus Japanese encephalitis (Torres Strait Islands only) Kunjin virus *Angiostrongylus cantonensis*

CNS infections: meningitis and encephalitis with symptoms for more than four weeks and in the immunocompromised host*

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
HIV *Mycobacterium tuberculosis* *Tropheryma whipplei*	*Nocardia* spp. Polyomavirus *Cryptococcus* spp. JC virus *Mycobacterium tuberculosis* *Toxoplasma gondii* *Acanthamoeba* spp.

*Consider noninfectious causes like vasculitis and lymphoma.

Ear, nose, and throat infections

Ear, nose, and throat infections with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
Group A streptococci (streptococcal throat infection)	Peritonsillar abscess*	*Corynebacterium diphtheriae*
Epstein–Barr virus	*Mycobacterium tuberculosis*	
Herpes simplex virus (type I and II)	*Fusobacterium necrophorum* (Lemierre's syndrome)	

*Requires acute ENT evaluation.

Ear, nose, and throat with symptoms for more than four weeks and in the immunocompromised host*

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Mycobacterium tuberculosis	*Candida* spp. Herpes simplex virus

*Consider noninfectious causes like vasculitis and lymphoma.

Cardiopulmonary infections

Pneumonia with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
Streptococcus pneumoniae	*Coxiella burnetii* (Q-fever)	*Corynebacterium diphtheriae*
Mycoplasma pneumoniae	Influenza virus	*Burkholderia pseudomallei*
Chlamydia psittaci	Parainfluenza virus	Hendra virus
Legionella pneumophila		
Chlamydia pneumoniae		

Endocarditis with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
Staphylococcius aureus	*Neisseria gonorrhoeae*	*Bartonella* spp.
Viridans group streptococci and *S.bovis*	*Coxiella burnetii**	*Brucella* spp.
Coagulase-negative *Staphylococcus* (*S. epidermidis*)	*Propionibacterium*	*Tropheryma whipplei*
Enterococcus spp.	HACEK group	
	Streptococcus pneumoniae	

*Q-fever has not been reported from New Zealand.

Pulmonary symptoms for more than four weeks and in the immunocompromised host*

Microorganisms and diseases with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Mycobacterium tuberculosis	*Pneumocystis jiroveci*
Bordetella pertussis	CMV
Aspergillus spp.	*Aspergillus* spp.
	Candida spp.

*Consider noninfectious causes like lung cancer, autoimmune lung fibrosis, and Wegener's granulomatosis.

Endocarditis for more than four weeks and in the immunocompromised host*

Microorganisms and diseases with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Viridans group streptococci and *S.bovis* Coagulase-negative staphylococci (*S. epidermidis*) *Coxiella burnetii*† *Bartonella* spp.	*Aspergillus* spp. *Tropheryma whipplei*

*Consider noninfectious causes like sarcoidosis.
†Q-fever has not been reported from New Zealand.

Gastrointestinal infections

Gastrointestinal infections with less than four weeks of symptoms*

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
Norovirus and calicivirus, rotavirus *Campylobacter* spp. Enteropathogenic *E. coli* *Giardia intestinalis*† *Salmonella* spp. (non-*typhi*) *Enterobius vermicularis* (pinworm)	*Cryptosporidium* spp. *Staphylococcus aureus* toxin *Bacillus cereus* toxin *Ascaris lumbricoides* *Strongyloides stercoralis* *Ancylostoma caninum* *Shigella* spp. *Trichuris trichiura* *Aeromonas* spp. *Entamoeba dispar*	*Mycobacterium tuberculosis* *Tropheryma whipplei*

*Consider noninfectious causes like inflammatory bowel disease and intestinal malignancies like colon cancer.
†*Giardia intestinalis* can occur throughout Australia and New Zealand, but it is particularly endemic in Tasmania.

Diarrhea is often associated with infections with bacteria, viruses, and parasites. Repeated negative bacterial cultures and microscopy for parasites should lead to the consideration that the symptoms may not be caused by an infection. Inflammatory bowel diseases like ulcerative colitis and Crohn's disease are part of the differential diagnosis and malabsorption and celiac disease must also be considered.

Gastrointestinal infections with symptoms for more than four weeks and in the immunocompromised host*

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Mycobacterium tuberculosis *Tropheryma whipplei* *Blastocystis hominis*† *Dientamoeba fragilis*†	*Candida* spp. Herpes virus, cytomegalovirus

(*Continued*)

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Echinococcus granulosus *Enterobius vermicularis* *Strongyloides stercoralis*** *Ancylostoma duodenale* (hookworm)** *Ascaris lumbricoides*** *Trichuris trichiura***	

*Consider noninfectious causes like inflammatory bowel disease, intestinal malignancies like colon cancer, malabsorption, and celiac disease.
†Of uncertain pathogenicity in humans.
**Mainly occur in the tropical north of Australia.

Infections of liver, spleen, and peritoneum

Acute infections of liver, spleen, and peritoneum with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
Hepatitis A Hepatitis B Hepatitis C	*Entamoeba histolytica*	*Fasciola hepatica* Hepatitis E

Chronic infections of liver, spleen, and peritoneum with more than four weeks of symptoms and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Mycobacterium tuberculosis *Tropheryma whipplei*	*Mycobacterium avium* complex

Infections in the immunocompromised host are generally similar to those in the immunocompetent host.

Genitourinary infections

Cystitis, pyelonephritis, and nephritis with less than four weeks of symptoms*

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
E. coli *Klebsiella pneumoniae*		*Mycobacterium tuberculosis*

*Consider noninfectious causes, especially malignancies like renal cell carcinoma.

Sexually transmitted infections with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms
Chlamydia spp. *Neisseria gonorrhoeae* Herpes simplex	*Treponema pallidum*	

Cystitis, pyelonephritis, and nephritis with symptoms for more than four weeks and in the immunocompromised host*

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Mycobacterium tuberculosis	*Candida* spp.

*Consider noninfectious causes, especially malignancies like renal cell carcinoma.

Sexually transmitted infections with symptoms for more than four weeks and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Treponema pallidum	

Joint, muscle, and soft tissue infections

Joint, muscle, and soft tissue infections with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms and conditions
Staphylococcus aureus *Streptococcus pneumoniae* Ross River virus Barmah Forest virus	Necrotizing fasciitis Group G streptococci Dengue	

Joint, muscle, and soft tissue infections with more than four weeks of symptoms and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Mycobacterium tuberculosis	*Candida* spp.

Skin infections

Skin infections with less than four weeks of symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms and conditions
Erysipelas (*S. pyogenes*), *Streptococcus pneumoniae*	Scabies	*Vibrio vulnificus*
Staphylococcus aureus	Necrotizing fasciitis caused by group A streptococcal spp.	

We have not listed a rash due to viral infections as this is not considered an infection limited to the skin.

Skin infections with more than four weeks of symptoms and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Treponema pallidum	*Candida* spp.
Mycobacterium tuberculosis	
*Mycobacterium ulcerans**	

* *Mycobacterium ulcerans* has not been reported from New Zealand.

Adenopathy

Adenopathy of less than four weeks duration

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms and conditions
Epstein–Barr virus	*Bartonella henselae*	
Cytomegalovirus		
Parvovirus B19		
Toxoplasma gondii		
HIV		

Adenopathy of more than four weeks duration and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Toxoplasma gondii	CMV
Mycobacterium tuberculosis	*Mycobacterium avium* complex
Nontuberculous mycobacteria spp.	

If the diagnosis is not made within a few days, biopsies should be performed to exclude malignancies like lymphoma and carcinomas.

Fever without focal symptoms

Fever less than four weeks without focal symptoms

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms and conditions
Endocarditis	*Mycobacterium tuberculosis*	
Epstein–Barr virus	*Coxiella burnetii**	
Cytomegalovirus	*Bartonella henselae*	
Parvovirus B19	Leptospirosis	
Toxoplasma gondii	*Rickettsial* spp.	
HIV	Dengue virus	
	Brucella suis	

*Q-fever has not been reported from New Zealand.

Fever for more than four weeks without focal symptoms and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Toxoplasma gondii	CMV
Mycobacterium tuberculosis	

All patients with adenopathy should have a CT or MR scan of the thorax and abdomen performed soon to determine the extent of the adenopathy and to enable decision of the best approach to biopsy. PET-CT will provide clues for inflammatory foci and malignancies. Noninfectious causes like lymphoma, other malignancies, and autoimmune diseases should be considered early.

Eosinophilia and elevated IgE

Eosinophilia and elevated IgE for less than four weeks

Frequently found microorganisms	Rare microorganisms and conditions	Very rare microorganisms and conditions
	Toxocara spp.	*Fasciola hepatica*
	Ascaris lumbricoides, *Trichuris trichiura*, hookworm	
	Strongyloides stercoralis	

Eosinophilia and elevated IgE for more than four weeks and in the immunocompromised host

Microorganisms with symptoms for more than 4 weeks	Microorganisms in the immunocompromised host
Ascaris lumbricoides, *Trichuris trichiura*, hookworm *Strongyloides stercoralis*	*Toxocara* spp.

Basic diagnostics in patients with eosinophilia and elevated IgE

Microorganism	Diagnostics
Ascaris lumbricoides, *Trichuris trichiura*, hookworm	Fecal microscopy
Toxocara spp.	Serology
Strongyloides stercoralis	Fecal microscopy, serology
Fasciola hepatica	Fecal microscopy, serology, imaging

Antibiotic resistance

Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) is not an infrequent cause of *S. aureus* infections in patients presenting to medical practitioners and hospitals. The spectrum of infections includes skin and soft tissue infections, bacteremia, and community-acquired pneumonia. The highest rates have been reported from Western Australia, the Northern Territory and Queensland, but CA-MRSA skin infections have now also been reported from Brisbane, Sydney, Canberra, and Melbourne. In Western Australia, the notification rate for CA-MRSA in the metropolitan areas of Perth is as high as 144/100 000 population. In Darwin, CA-MRSA has accounted for up to 20% of community-onset *S. aureus* bacteremias, with a substantial proportion of patients having infective endocarditis. National surveillance has shown significant increases in the proportion of CA-MRSA isolates over the last 10–15 years. The most frequent clonal isolates have included ST1-MRSA-IV (Western Australia, Northern Territory, and South Australia) followed by ST93-MRSA-IV (Queensland and New South Wales) and ST30-MRSA-IV (Northern Territory, Queensland, and New South Wales). ST129-MRSA-IV and ST5-MRSA-IV are most frequently encountered in Victoria, Tasmania, and Western Australia [25].

Although cases of high-level penicillin-resistant *Pneumococcus* causing pneumonia or meningitis have been reported, they are infrequent (<5%). ESBL and MBL gram-negative infections are also uncommon and are seen almost exclusively as nosocomial infections or in travelers returning from areas such as South and South-east Asia.

Vaccine-preventable diseases in children

Australia has a national immunization program schedule (funded by the Australian government) which currently includes vaccines against a total of 16 diseases. There is also an Australian Childhood Immunization Register (the ACIR), which aims to provide (i) an accurate measure of the immunization

coverage of children in Australia under seven years of age and (ii) an effective management tool for monitoring immunization coverage and service delivery. The childhood vaccination schedule consists of the vaccines listed below [26] and over 90% of children are fully vaccinated.

- Birth: hepatitis B
- 2, 4, and 6 months: diphtheria, tetanus, pertussis, polio, Hib, hepatitis b, pneumococcal, rotavirus
- 12 months: measles, mumps, rubella, Hib, meningococcal C
- 18 months: varicella, measles, mumps, rubella
- 12–24 months: hepatitis A and pneumococcal polysaccharide (23vPPV) (only for Aboriginal and Torres Strait Islander children in high-risk areas)
- 4 years: diphtheria, tetanus, pertussis, polio (plus measles, mumps, rubella if not given previously)
- 10–15 years: diphtheria, tetanus, pertussis, human papillomavirus, varicella

The NZ national immunization schedule (New Zealand Ministry of Health, 2006, 2008) currently includes vaccines against a total of 13 diseases offered free to babies, children, adolescents, and adults. NZ also has a National Immunization Register. Approximately 93% of children are fully immunized by two years of age [27].

- 6 weeks, 3 and 5 months: diphtheria, tetanus, acellular pertussis, polio, *Haemophilus influenzae* type b, hepatitis B
- 6 weeks, 3 and 5 months: rotavirus
- 6 weeks, 3 and 5 and 15 months: 13-valent pneumococcal conjugate vaccine
- 15 months: *Haemophilus influenzae* type b
- 15 months: measles, mumps, rubella
- 4 years: measles, mumps, rubella, diphtheria, tetanus, acellular pertussis
- 11 years: tetanus, diphtheria, acellular pertussis
- 12 years (girls only): human papillomavirus (three doses)
- 45 and 65 years: adult tetanus and diphtheria
- All adults 65 years and over and high-risk other groups: seasonal influenza[xbl]

There are additional scheduled vaccines offered.

- BCG to babies who will be living in a household or family with a person with either current TB or a past history of TB, have one or both parents who are of Pacific ethnicity, have parents or household members who, within the past five years, lived for a period of six months or longer in a country with a high incidence of TB, during their first five years will be living for three months or longer in a country with a high incidence of TB.
- Babies of HBsAg-positive mothers need HBIG and hepatitis B vaccine at birth; then they continue with the usual schedule at six weeks, three and five months.
- Women of childbearing age who are nonimmune to rubella are offered the MMR vaccine.

Basic economic and demographic data*

	GNI per capita (USD)	Life expectancy at birth (total, years)	School enrollment, primary (% net)
Australia	40350	81	97
New Zealand	27940	80	99

*World Bank (www.worldbank.org)
GNI, gross national income.

Causes of death in children under five in Australia*

	%
Neonatal causes	56
Pneumonia	1
Diarrheal diseases	0
Malaria	0
HIV/AIDS	0
Measles	0
Injuries	11
Others	

*WHO 2006. www.who.int/whosis/mort/profiles/en/#P

Most common causes of deaths all ages in Australia

	%
Ischemic and hypertensive heart disease	20
Cerebrovascular disease	9
Lower respiratory infections	2
Perinatal conditions	NS
Tuberculosis	NS
Diarrheal disease	NS
Measles	NS
Chronic obstructive lung disease	4
Malnutrition	NS
Diabetes	3
Alzheimer's and other dementias	3
Nephritis and nephrosis	NS
Cancers	14
Asthma	NS
Endocrine disorders	NS

NS, not stated.

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