Childhood immunisation in Australia 2015 update

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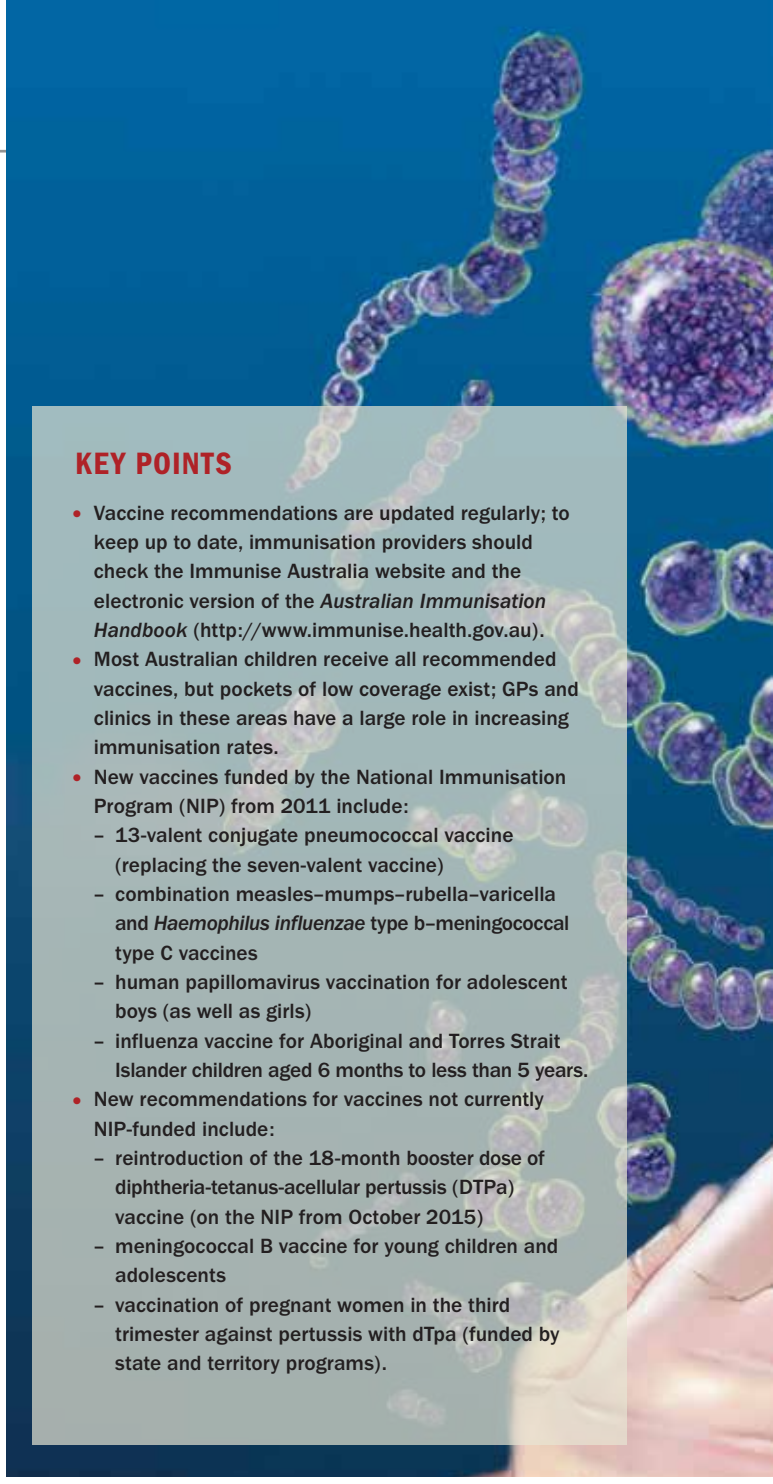
Changes to childhood immunisation in Australia in the past five years include new vaccines funded by the National Immunisation Program, such as combination measles–mumps–rubella–varicella and pneumococcal vaccines, and new influenza and pertussis vaccine recommendations for children and pregnant women.

Over recent years, the National Immunisation Program (NIP) schedule for children and adolescents has expanded, with new vaccines and changes to recommendations for existing vaccines. Keeping up with changes in immunisation is challenging; here, we give an overview of the latest updates, the rationale behind new recommendations and key resources. The current NIP schedule for children aged up to 17 years is reflected in the Table. Key resources are listed in the Box.



KEY POINTS

- Vaccine recommendations are updated regularly; to keep up to date, immunisation providers should check the Immunise Australia website and the electronic version of the *Australian Immunisation Handbook* (http://www.immunise.health.gov.au).
- Most Australian children receive all recommended vaccines, but pockets of low coverage exist; GPs and clinics in these areas have a large role in increasing immunisation rates.
- New vaccines funded by the National Immunisation Program (NIP) from 2011 include:
  - 13-valent conjugate pneumococcal vaccine (replacing the seven-valent vaccine)
  - combination measles–mumps–rubella–varicella and *Haemophilus influenzae* type b–meningococcal type C vaccines
  - human papillomavirus vaccination for adolescent boys (as well as girls)
  - influenza vaccine for Aboriginal and Torres Strait Islander children aged 6 months to less than 5 years.
- New recommendations for vaccines not currently NIP-funded include:
  - reintroduction of the 18-month booster dose of diphtheria-tetanus-acellular pertussis (DTPa) vaccine (on the NIP from October 2015)
  - meningococcal B vaccine for young children and adolescents
  - vaccination of pregnant women in the third trimester against pertussis with dTpa (funded by state and territory programs).

Australia's NIP is one of the most comprehensive funded national immunisation programs in the world, providing vaccines for 16 different diseases at multiple schedule points. Most vaccines on the NIP are for infants and young children. It is important to ensure that protection against disease is achieved before the age of greatest risk if possible. We previously published an update on childhood immunisation in 2009; here, we provide an overview of the most recent changes since then.[1] Although immunisation needs during adulthood are not the focus of this article, it is also important to review these.[2] This is to ensure that all childhood and adolescent doses have been received, to protect against 'new' disease risk or to boost immunity achieved following infant vaccinations.

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Delivery of the NIP

The NIP is a collaborative program involving the Australian federal, state and territory governments, as recently described in the National Immunisation Strategy for Australia 2013–2018.[3] The success of the NIP relies on thousands of dedicated health professionals across Australia comprising general practitioners, nurses, Aboriginal and Torres Strait Islander health workers, public health staff, researchers and others, all working in different settings. Immunisation coverage is high and stable, with more than 90% of children at 12, 24 and 60 months of age reported as fully immunised according to the Australian Childhood Immunisation Register (ACIR) in 2013.[4] Coverage in girls with all three doses of human papillomavirus (HPV) vaccine by 15 years of age is 71%, which is higher than what has been achieved in most European countries or the USA.[5] Impressive reductions have occurred in vaccine-preventable diseases, including those for which routine vaccination is relatively new, such as meningitis (from meningococcal type C, *Haemophilus influenzae* [Hib] and pneumococcus), gastroenteritis (from rotavirus), varicella and measles.[6-9]

However, vaccine coverage is lower than the national average within some geographical areas and subpopulations (e.g. Aboriginal and Torres Strait Islanders, culturally and linguistically diverse communities, recent migrants, refugees and asylum seekers).[10] Very high coverage (more than 95%) is particularly needed to maintain a level of herd or 'community' immunity sufficient to prevent diseases such as measles. Despite the WHO declaring elimination of endemic measles transmission from Australia in March 2014, small measles outbreaks in underimmunised populations still occur, typically following importation of the virus by individuals exposed to measles overseas.[11]

In general terms, lack of vaccination is due to a number of reasons: access issues, vaccine hesitancy and vaccine refusal due to personal beliefs; rarely is it due to medical contraindications. Only a small proportion of unvaccinated children (less than 2%) have parents who have a 'conscientious objection' to vaccination. New measures announced by the Australian Government in April to May 2015 remove eligibility for tax and childcare rebates for parents of children aged up to 18 years who refuse immunisation, allowing only medical exemptions. This will be supported by the development of a national adolescent immunisation register, which will be extended to include adults in coming years. Financial incentives for GPs to vaccinate children who are not up to date and the development of communication materials to increase community understanding of vaccination and reduce vaccine hesitancy are also planned.

How to keep up with changes in immunisation

New recommendations on the use of vaccines in Australia, including NIP-funded vaccines, occur from time to time as new vaccines become available or new evidence emerges on vaccine effectiveness, safety or disease epidemiology. There is an extremely rigorous process for evaluating any new vaccine recommendations and changes to the NIP, which involves extensive review of available data by key expert advisory groups.[12]

The *Australian Immunisation Handbook* is the definitive resource for national recommendations on vaccines available in Australia, including routine vaccines for the general population as well as those for special risk patients, such as individuals with underlying medical conditions and Aboriginal and Torres Strait Islander children and adults.[13] The handbook is prepared by the Australian Technical Advisory Group on Immunisation (ATAGI) and the National Centre for Immunisation Research and Surveillance (NCIRS). The NIP schedule card outlining which vaccines are NIP funded is also provided with the handbook but can be updated online separately. The most recent edition of the

TABLE. NATIONAL IMMUNISATION PROGRAM SCHEDULE AT A GLANCE FOR CHILDREN AGED UP TO 17 YEARS*

	Birth	2 months†	4 months	6 months	12 months	18 months	4 years	10–15 years	⩾15 years
Hep B	✓†¶	✓	✓	✓†	(✓)†			✓†	
DTPa (dTpa§)		✓	✓	✓		‖	✓	✓§	
IPV		✓	✓	✓			✓		
Hib		✓	✓	✓	✓¶				
13vPCV**		✓	✓	✓	(✓)**				
Rotavirus		✓	✓	(✓)††					
MMR					✓	✓#			
VV						✓#		✓§§	
MenCCV					✓¶				
HPV								✓‖‖	
Hep A¶¶					✓¶¶	✓¶¶			
Influenza				✓***					✓***
23vPPV						✓†††	✓**		✓†††

Abbreviations: 13vPCV = pneumococcal conjugate (13-valent) vaccine; 23vPPV = pneumococcal polysaccharide (23-valent) vaccine; DTPa = diphtheria, tetanus, acellular pertussis vaccine; dTpa = adolescent/adult formulation diphtheria, tetanus, acellular pertussis vaccine; Hep A = hepatitis A vaccine; Hep B = hepatitis B vaccine; Hib = *Haemophilus influenzae* type b vaccine; HPV = human papillomavirus vaccine; Influenza = annual influenza vaccine; IPV = inactivated poliomyelitis virus vaccine; MMR = measles, mumps, rubella vaccine; MMRV = measles, mumps, rubella, varicella vaccine; MenCCV = meningococcal C conjugate vaccine; Rotavirus = rotavirus vaccine (oral only); VV = varicella–zoster virus vaccine.

* Adapted from the National Immunisation Program (NIP) schedule and National Centre for Immunisation Research and Surveillance childhood immunisation fact sheet (www.ncirs.edu.au). The NIP schedule is updated periodically, and the current schedule is available at www.immunise.health.gov.au. This schedule does not include all vaccines recommended for use in children in the *Australian Immunisation Handbook* (AIH).[13] For example, meningococcal B vaccine is recommended for young children and adolescents but is not NIP-funded.

† The first doses can be given as early as 6 weeks of age, because of the high morbidity and occasional mortality associated with pertussis in very young infants. If the first dose is given at 6 weeks of age, the next scheduled doses should still be given at 4 months and 6 months of age.

† Hepatitis B vaccine should be given to all infants as soon as practicable after birth. It has the greatest benefit if given within 24 hours and must be given within seven days. A total of three doses of hepatitis B vaccine are required following the birth dose, at 2, 4 and 6 months of age. Catch-up hepatitis B vaccination (given as either a two- or three-dose course) is provided to adolescents with no prior history of disease or vaccination.

§ Given as dTpa (adult formulation triple antigen).

‖ DTPa–IPV booster dose recommended for use at 18 months by the AIH and NIP funded from October 2015.

¶ If using PRP-T Hib (purified *Haemophilus influenzae* capsular polysaccharide bound to tetanus toxoid), give four doses at 2, 4, 6 and 12 months of age. If using PRP-OMP (purified *H. influenzae* capsular polysaccharide bound to *Neisseria meningitidis* outer membrane protein), give three doses at 2, 4 and 12 months of age. May be administered as either single doses of PRP-T or PRP-OMP Hib and MenCCV or as a combination PRP-T/MenCCV vaccine.

** Medically at-risk children require a fourth dose of 13vPCV at 12 months of age and a dose of 23vPPV at 4 years of age. Aboriginal and Torres Strait Islander children living in high-risk areas (Queensland, the Northern Territory, Western Australia and South Australia) require a fourth dose of 13vPCV at 12 to 18 months of age. Contact your state or territory health department for details.

†† The requirement for a third dose of rotavirus vaccine depends on the vaccine brand used. Contact your state or territory health department for details.

Given as combination MMRV vaccine.

§§ If no prior history of disease or vaccination: if aged <14 years, at least one dose of monovalent VV given as catch-up; and if aged ≥14 years, two doses given as a catch-up separated by a four-week interval.

‖‖ A three-dose series of HPV vaccine is required for all adolescents aged between 12 and 13 years. Contact your state or territory health department for details on the school grade eligible for vaccination.

¶¶ Two doses of hepatitis A vaccine are required for Aboriginal and Torres Strait Islander children aged between 12 and 24 months living in areas of higher risk (Queensland, the Northern Territory, Western Australia and South Australia). Contact your state or territory health department for details.

*** Influenza vaccine is recommended annually for children 6 months of age and older who are medically at-risk of serious complications from influenza, and for Aboriginal and Torres Strait Islander children aged 6 months to less than 5 years and aged 15 years and over.

††† Recommended for Aboriginal and Torres Strait Islander children living in areas of higher risk (Queensland, the Northern Territory, Western Australia and South Australia) at 18 to 24 months of age, and Aboriginal and Torres Strait Islander adolescents.

handbook is the 10th edition published in 2013; however, a hard copy updated in January 2014 is also available. The next update to advice provided in some chapters of the 10th edition of the handbook is expected in July 2015 and will be available online only. All immunisation providers should check regularly for new information and updated chapters of the handbook at the Immunise Australia Program website (http://www.immunise.health.gov.au) or subscribe to handbook alerts.

State and territory health departments also provide information on NIP vaccines specific to their jurisdiction and any state-funded programs. Immunisation co-ordinators from state or local public health units and general practice networks are an invaluable resource. The NCIRS website also contains very detailed fact sheets on vaccines and vaccine-preventable diseases (http://www.ncirs.edu.au/immunisation/fact-sheets/index.php).

USEFUL RESOURCES ON IMMUNISATION

Up-to-date immunisation schedules

- *Australian Immunisation Handbook* (10th ed. 2013, updated 2014)* (http://www.immunise.health.gov.au)
- Handbook update alerts (subscribe at http://www.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook10-home~handbook10-tools~handbook10-subscribe)
- National Immunisation Program (NIP) schedule card (http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/national-immunisation-program-schedule)
- Immunise Australia website (http://www.immunise.health.gov.au)
- National Centre for Immunisation Research and Surveillance (NCIRS) (www.ncirs.edu.au)
- State and territory health departments
- Immunisation co-ordinators (state and local public health units, and general practice networks)

Answering parents' questions

- Australian Government Department of Health. *Myths and Realities: Responding to Arguments against Vaccination – a Guide for Providers* (http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/uci-myths-guideprov)
- Australian Academy of Sciences. *The Science of Immunisation: Questions and Answers* (https://www.science.org.au/immunisation)
- NCIRS fact sheets on childhood immunisation, vaccines and vaccine-preventable diseases (http://www.ncirs.edu.au/immunisation/fact-sheets/index.php)

* An electronic update is expected in July 2015.

New vaccines on the NIP schedule

Pneumococcal disease

Approaches to immunisation against pneumococcal disease have evolved over the past 25 years as our understanding of disease epidemiology and vaccine development has progressed. Routine vaccination of infants against pneumococcus was implemented in 2005 when a seven-valent conjugate pneumococcal vaccine (7vPCV) was added to the NIP at 2, 4 and 6 months of age. This led to a 78% reduction in invasive pneumococcal disease caused by vaccine serotypes in children aged under 5 years and extensive herd immunity in older age groups.[6,14] However, in recent years, rates of invasive pneumococcal disease caused by non-7vPCV serotypes, in particular the 19A serotype, have begun to rise.

In 2011, a 13-valent conjugate pneumococcal vaccine (13vPCV) replaced 7vPCV for routine childhood vaccinations on the NIP, and in 2012, it replaced the 23-valent polysaccharide vaccine (23vPPV) as the booster dose for Indigenous children at 12 to 18 months of age. The 13vPCV contains a further six serotypes in addition to the seven included in the 7vPCV. Reductions in invasive pneumococcal disease caused by 13vPCV serotypes not present in the seven-valent vaccine have now been observed in children under 5 years of age, both in Australia and in other countries that have introduced the 13vPCV.[15] It is important to understand that although conjugate pneumococcal vaccines protect against fewer serotypes than the 23vPPV, they are more effective in reducing bacterial carriage, inducing immune memory and thus generating herd immunity. Ongoing surveillance of pneumococcal disease and causative serotypes continues to be important to monitor for vaccine impact and further potential serotype replacement.

Children and adults with underlying medical conditions that increase their risk of invasive pneumococcal disease are recommended to have booster doses of 23vPPV following initial immunisation with 13vPCV. Additional doses of pneumococcal vaccines are recommended for Aboriginal and Torres Strait Islander people. Recommendations on the number and timing of additional doses in these special situations are described in detail in the handbook.[13]

Measles, mumps, rubella and varicella

Updates to the NIP for vaccination against measles, mumps, rubella and varicella were introduced in July 2013 with the availability of a new combination vaccine against all four diseases: MMRV (measles-mumps-rubella-varicella) vaccine. The first dose of MMR vaccine is still to be administered at 12 months of age; however, the second vaccine dose is now recommended at 18 months rather than 4 years of age and is now provided as a four-in-one MMRV formulation.

The MMRV vaccine replaces the monovalent varicella vaccine previously recommended at age 18 months. This change means that children will receive one less injection by the time they turn 4 years old and will have received two doses of an MMR-containing vaccine at an earlier age.[16] MMRV is only recommended for use as the second (not the first) dose of an MMR-containing vaccine in children less than 4 years of age as a twofold increased risk of fever and febrile seizures has been observed when four-in-one MMRV is used as the first dose in young vaccine-naïve children.[17]

Giving MMRV vaccine at 18 months of age is also expected to increase the number of children who receive varicella vaccine, which was sometimes forgotten, possibly because it was the only vaccine recommended at the 18-month schedule point. Varicella-associated hospitalisations in children aged 18 to 59 months have declined by 75% following NIP funding of the single dose of varicella vaccine in 2005.[18] However, it is also worth noting that a second dose of varicella vaccine provides even greater protection against varicella and is recommended (but not NIP funded) for children under 14 years of age to reduce the likelihood of breakthrough disease.[19]

Changes to existing NIP vaccines

Influenza

Influenza is a serious infectious disease with the highest associated morbidity and mortality in people at the extremes of age (young children and the elderly), in those with underlying medical

conditions and in Aboriginal and Torres Strait Islander people. Trivalent influenza vaccines were first subsidised for certain at-risk groups in 1999, with the NIP expanding eligibility steadily since then. In 2010, access to trivalent influenza vaccines for children 6 months of age and older (and adults) with certain medical conditions was moved from being subsidised under the PBS to the NIP. This includes pregnant women, for whom immunisation protects not only them from influenza, but also their baby from in utero up to 6 months of age.

From 2015, the NIP has been expanded to include annual trivalent influenza vaccines for Aboriginal and Torres Strait Islander children aged 6 months to less than 5 years. Indigenous children aged 15 years and older can also receive NIP-funded vaccine; although not NIP-funded, immunisation of Indigenous children aged 5 to less than 15 years is also recommended. Because influenza can be a significant illness in anyone, irrespective of age or health status, the handbook recommends that anyone who wishes to protect themselves against influenza be offered vaccination.[13] The annual influenza vaccine statements published by ATAGI provide excellent information on vaccine recommendations, funding and availability.[20]

Inactivated quadrivalent influenza vaccines are available in Australia from 2015 (on private prescription) and are currently being considered for inclusion on the NIP. Inactivated quadrivalent influenza vaccine includes four influenza virus strains: the same two influenza A strains and single B strain included in the trivalent influenza vaccine plus an additional influenza B strain. Immunisation with quadrivalent influenza vaccine has the potential to offer an additional benefit over trivalent influenza vaccine; however, the degree of extra benefit will depend on the influenza virus strains circulating that season, among other factors.[21]

Pertussis

Whooping cough (pertussis), caused by *Bordetella pertussis* infection, remains a significant public health issue in Australia despite consistently high levels of coverage (more than 92%) with diphtheria–tetanus–acellular pertussis (DTPa)-containing vaccines for the past 14 years. The most recent Australian outbreak resulted in significant morbidity and mortality, particularly in the most vulnerable age groups: 10 deaths and 1800 hospitalisations in infants under 6 months of age were reported in Australia from 2006 to 2012. The high pertussis incidence seen in Australia is in part due to increased recognition of disease and improved detection through more widespread and sensitive testing using polymerase chain reaction (PCR) based assays.[22] However, evidence from a range of studies also indicates that immunity from acellular pertussis vaccines (which replaced the more adverse reaction-prone 'whole cell' vaccines approximately 15 years ago) wanes more rapidly than expected. A recent Australian study showed that following the three-dose primary series in infancy (recommended at ages 6 weeks, 4 and 6 months) vaccine effectiveness waned by the second and third year of life to only about 60%.[23] As a result, reintroduction of a booster dose of the DTPa vaccine at 18 months of age has been recommended, and it will be available under the NIP from October 2015.[13]

Because pertussis has its most serious effects in children under the age of 6 months who are too young to have received full protection from the primary immunisation series, several strategies have been employed to address the vulnerability of the youngest babies. These include:

- lowering the recommended age for the first dose of hexavalent DTPa–hepatitis B–inactivated poliomyelitis virus–Hib vaccine from 2 months to 6 weeks of age (from 2011)
- maternal vaccination
- indirect protection of the newborn through 'cocooning' – ensuring all contacts, including parents and other adults, have had pertussis vaccine.

Although all these strategies are important, postpartum vaccination of mothers is less effective than pertussis vaccination during pregnancy. In addition to reducing infant exposure to maternal infection, vaccination of women in the third trimester of every pregnancy allows passive transplacental transfer of high levels of maternal antibody to the baby and has been shown to be 90% effective in preventing pertussis infection in babies younger than 2 months.[24] It is now recommended that pregnant women be given a pertussis vaccine booster (dTpa) from 28 weeks' gestation as part of their prenatal care with every pregnancy.[13] This has been introduced as a funded program in all states and territories, and GPs play an important role in ensuring this occurs. The local state health department should be contacted for up-to-date information.

Human papillomavirus

The NIP-funded national HPV immunisation program has been in place for almost eight years, initially providing the quadrivalent (4vHPV) vaccine to females in the age range older than 9 years to less than 26 years. Funded catch-up 4vHPV immunisation for older women was short term and ceased in 2009, leaving the present ongoing school-based program for girls aged 12 to 13 years. The positive impact of the female program on HPV-related diseases was observed soon after introduction, with significant decreases in the incidence of infection, genital warts and cervical lesions caused by vaccine HPV serotypes in girls and women eligible for vaccination.[25-27]

Following the availability of clinical data demonstrating the effectiveness of 4vHPV vaccine in adolescent boys and young men and an increasing awareness of the role that oncogenic HPV strains play in the aetiology of a range of cancers, including head and neck cancers, the NIP was expanded in 2013 to include males. Routine school-based immunisation of adolescent boys aged 12 to 13 years, along with a short-term catch-up program for boys aged 14 to 15 years, which ran to the end of the 2014 school year, has been well received. This 'sex-neutral' program provides direct

protection to young males against HPV-associated diseases.[28] Preliminary data suggest that the coverage rate in adolescent boys is similar to that achieved in adolescent girls.

In light of the success of routine HPV vaccination in reducing the frequency of cervical abnormalities at a population level and a range of other factors, changes to the National Cervical Screening Program are expected to be implemented in the coming years and will focus primarily on the detection of HPV infection rather than precancerous cervical lesions.

Meningococcus

Currently, only vaccination against meningococcal serogroup C (MenC) is provided under the NIP. This was introduced in 2003 as a single dose of a MenC conjugate vaccine at 12 months of age and has resulted in a 92% reduction in notifications of meningococcal C disease.[29] In July 2013, the MenC conjugate vaccine funded through the NIP was replaced with a *H. influenzae* type b and MenC combination vaccine (Hib-MenC), which means that the vaccines recommended at the 12-month schedule point are administered with one less injection. Use of the combination vaccine can lead to special considerations when planning catch-up schedules. ATAGI has prepared specific advice to assist in planning immunisation catch-up programs using combination vaccines, which can be used in conjunction with the general principles outlined in the handbook.[30]

Serogroup B is now the predominant circulating meningococcal serogroup and is responsible for approximately 200 cases per year, which represents 85% of meningococcal disease in which specific serogrouping has been confirmed. Peaks in meningococcal B disease incidence are seen in early childhood (particularly in infants) and again in adolescence (around 15 to 18 years). The first registered vaccine against a wide range of meningococcal serogroup B strains (representing approximately 76% of existing strains based on in vitro studies) was registered for use in Australia in late 2013 (MenB vaccine). This vaccine is not currently funded on the NIP but is available by private prescription.

ATAGI recommends the MenB vaccine for young children aged 6 weeks to less than 5 years (especially under 24 months of age) and also adolescents aged 15 to 19 years. Four doses are needed for babies starting the schedule from less than 6 months of age, but only two doses for older children and adults. Further advice can be found in the ATAGI statement and in the update to the meningococcus chapter in the handbook, expected later in 2015.[31] Prophylactic administration of paracetamol is recommended with every dose of this vaccine given to children under 2 years of age. This is an exception to the general recommendation to not give paracetamol at the time of other immunisations. This specific recommendation derives from the results of studies showing an increased risk of fever following MenB vaccine administration in young children, particularly when co-administered with other vaccines commonly given to the 2 to 12-months age group. Without paracetamol, more than a quarter of infants who received MenB vaccine alone developed fever (temperature of 38°C or above) and 4 to 8% had fever with a temperature of 39°C or above.[32] Fever is also more common when MenB vaccine is co-administered with other vaccines.

Two different types of quadrivalent meningococcal vaccine (conjugate and polysaccharide) provide protection against serogroups A, C, Y and W135 and are now available for use in Australia. These vaccines are not funded for routine vaccination under the NIP; however, they are recommended for those who are at greater risk of disease caused by these serotypes, such as travellers to endemic areas and individuals with medical conditions that increase the risk of invasive meningococcal disease. The conjugate vaccines have a number of advantages over the polysaccharide vaccine and are the preferred formulations in certain circumstances, as discussed in the handbook update.

Vaccine impact and safety

As discussed above, the impact of immunisation on disease burden is continuously assessed. The need to adapt immunisation recommendations in light of changing disease epidemiology underpins the important role that all primary care providers have in reporting notifiable diseases to their state and territory public health authorities. Similarly, ensuring that vaccines are as safe in the field as they are in the clinical trials that support their registration requires that all immunisation providers have a good knowledge of adverse events following immunisation. Although most adverse events, such as injection site reactions and fever, are mild and short-lived, it is important that providers report any unusual, unexpected or serious adverse events following immunisation promptly to their relevant state and territory public health authorities, who in turn send all data to the TGA Adverse Drug Reactions System database.

For instance, GPs can now reassure parents that the influenza vaccines currently registered for use in children have an excellent safety record and are monitored closely each year. All providers are aware that one brand, Fluvax, is no longer registered for use in children under 5 years of age and is not recommended in children aged under 9 years because of a serious increased risk of fever and febrile seizures, which became evident in 2010.[33] Safety surveillance for influenza vaccines is conducted each year through AusVaxSafety – a national system that gathers weekly information from text message responses from parents on how their children felt post-vaccination – to ensure the ongoing safe profile of influenza vaccines (http://www.ncirs.edu.au/surveillance/ausvaxsafety/index.php). This system draws on data from two new tools that GPs can use in their practices to obtain parent and patient feedback on vaccine reactions. One system, SMARTVax, is automated through GP software (http://www.smartvax.com.au/about-smartvax.html), and another, Vaxtracker, allows response via a web-based survey (http://www.vaxtracker.net).

In certain instances, special active safety surveillance is planned to better understand potential adverse events following immunisation. This occurred for the second-generation rotavirus vaccines,

available in Australia from 2007. Two landmark Australian studies confirmed an increased but low absolute risk of a rare type of bowel obstruction (intussusception) following the first and second doses of each vaccine.[34] However, this increased risk, amounting to six extra cases per 100,000 infants vaccinated, is offset by the overwhelming benefits of the NIP-funded rotavirus program that has seen 7000 fewer hospitalisations annually in children aged under 5 years since vaccine introduction.[35] GPs need to advise parents to seek medical attention in the event of any signs of a serious abdominal condition in their baby, as prompt diagnosis and treatment of intussusception is important.

How to help parents hesitant about immunisation

Societal concerns regarding vaccine safety remain a challenge for healthcare providers and policy makers both in Australia and worldwide. As the incidence of vaccine-preventable diseases decreases, there is reduced public awareness of the seriousness and impact of vaccine-preventable diseases, and the visibility of serious, albeit rare, or unrelated adverse events following immunisation has increased. It is a challenge for GPs and all immunisation providers to respond to misinformation about vaccine safety, and some parents need considerable time to discuss their concerns.

Useful resources to help immunisation providers address parents' questions include the booklet *Myths and Realities: Responding to Arguments against Vaccination – a Guide for Providers*, which provides a wealth of helpful hints for use in family discussions about vaccines and is freely available for download or can be ordered in hard copy from the Immunise Australia website (see Box). The Australian Academy of Sciences also has an excellent booklet available free online or in hard copy, entitled *The Science of Immunisation: Questions and Answers* (see Box). Fact sheets with responses to commonly asked questions (e.g. about vaccines and allergy) and other vaccine safety areas are also available from the NCIRS website (http://www.ncirs.edu.au/immunisation/fact-sheets/index.php).

Children for whom complex questions arise about immunisation, including adverse events following immunisation, can be referred to a specialist immunisation clinic in their local region. These specialty clinics are based at major children's hospitals in NSW, Victoria, South Australia, Queensland and Western Australia. In areas where a clinic is not readily accessible, referral to a paediatrician for an initial review is often possible. In addition, for rural and remote patients, telehealth consultation with city-based specialists in immunisation and local GPs or paediatricians is also increasingly available. For children who have experienced an adverse event following immunisation, clinic evaluation can help determine if there is a causal association with a vaccine and often facilitate completion of the immunisation series in a medically observed setting.

On the horizon

The future for continued improvements in child health through immunisation, both in Australia and around the world, remains bright as additional pathogens are targeted and new vaccine technology is developed. The past several years have seen major advances in the development and testing of vaccines against diseases such as malaria, dengue and bacterial enteric infections, which are of relatively low frequency in Australia but of significant importance worldwide in terms of morbidity, mortality and economic impact.[36,37] In addition, recent clinical research into new vaccines for more commonly encountered pathogens, such as enterovirus 71 (one of the principal aetiological causes of hand, foot and mouth disease and associated with severe neurological disease) and *Staphylococcus aureus*, has been promising.[38,39]

The spectrum of cover of existing vaccines also continues to expand, with a nine-valent HPV vaccine expected to be available soon and further refinements in vaccine schedules also being examined.[40] In addition, a live attenuated influenza vaccine that is administered nasally and developed for each southern hemisphere season also appears to be finally on the near horizon. This all portends the continuing evolution of the NIP in years to come and further challenging but exciting changes.

Conclusion

All immunisation providers and persons involved in the delivery of immunisation programs in Australia have a collective mandate to achieve high vaccine coverage and thereby contribute to improved disease prevention in children and adults. Immunisation practice has become more complex in the current decade than it has ever been before; however, the promise of achieving better health through primary prevention rather than disease management makes it worthwhile. Many resources, both local and national, are available to support GPs and practice and clinic nurses in delivering vaccines under the NIP. We hope this overview helps in a small way to support their pivotal role. MT

References

A list of references is included in the website version (www.medicinetoday.com.au) and the iPad app version of this article.

COMPETING INTERESTS: None.

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2015 update

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References

1. Macartney K. What's new in childhood immunisation? Med Today 2009; 10(5): 24-30.
2. Georgousakis M, Jelfs J, Macartney KK. Immunisation for life: don't forget adults. Med Today 2011; 12(4): 29-37.
3. Australian Government. National immunisation strategy for Australia 2013-2018. Canberra: Australian Government Department of Health; 2013.
4. Hull B. Australian childhood immunisation coverage, 1 July to 30 September cohort, assessed as at 31 December 2013. Commun Dis Intell 2014; 38: E157-E158.
5. National HPV Vaccination Program Register. HPV vaccine coverage 2013. Available online at: http://www.hpvregister.org.au/research/coverage-data/hpv-vaccination-coverage-2013 (accessed July 2015)
6. Chiu C, Dey A, Wang H, et al. Vaccine preventable diseases in Australia, 2005 to 2007. Commun Dis Intell 2010; 34 Suppl: ix-S167.
7. Dey A, Wang H, Menzies R, Macartney K. Changes in hospitalisations for acute gastroenteritis in Australia after the national rotavirus vaccination program. Med J Aust 2012; 197: 453-457.
8. Heywood AE, Macartney KK. How can we better understand trends in varicella zoster virus-related disease epidemiology? Med J Aust 2011; 194: 268-269.
9. Heywood AE, Gidding HF, Riddell MA, McIntyre PB, MacIntyre CR, Kelly HA. Elimination of endemic measles transmission in Australia. Bull WHO 2009; 87: 64-71.
10. National Health Performance Authority. Healthy communities: immunisation rates for children in 2012–13. Sydney: NHP; 2014.
11. Wood JG, Heywood AE, Menzies RI, McIntyre PB, MacIntyre CR. Predicting localised measles outbreak potential in Australia. Vaccine 2015; 33: 1176-1181.
12. Nolan TM. The Australian model of immunization advice and vaccine funding. Vaccine 2010; 28: A76-A83.
13. Australian Technical Advisory Group on Immunisation. The Australian immunisation handbook. 10th ed (March 2015 update). Canberra: Australian Government Department of Health; 2015.
14. Jayasinghe S, Chiu C, Menzies R, Bareja C, Krause V, McIntyre P. Early impact of 3+0 schedule of 13vPCV in Australian children and adults [Abstract ISPPD-0429]. Pneumonia: special issue 9th International Symposium on Pneumococci and Pneumococcal Diseases. Hyderabad, India; 9-13 March 2014. Pneumonia 2014; 3: 148.
15. Miller E, Andrews NJ, Waight PA, Slack MP, George RC. Effectiveness of the new serotypes in the 13-valent pneumococcal conjugate vaccine. Vaccine 2011; 29: 9127-9131.
16. Wood JG, Gidding HF, Heywood A, Macartney K, McIntyre PB, MacIntyre CR. Potential impacts of schedule changes, waning immunity and vaccine uptake on measles elimination in Australia. Vaccine 2009; 27: 313-318.
17. MacDonald SE, Dover DC, Simmonds KA, Svenson LW. Risk of febrile seizures after first dose of measles-mumps-rubella-varicella vaccine: a population-based cohort study. CMAJ 2014; 186: 824-829.
18. Heywood AE, Wang H, Macartney KK, McIntyre P. Varicella and herpes zoster hospitalizations before and after implementation of one-dose varicella vaccination in Australia: an ecological study. Bull WHO 2014; 92: 593-604.
19. Kuter B, Matthews H, Shinefield H, et al. Ten year follow-up of healthy children who received one or two injections of varicella vaccine. Pediatr Infect Dis J 2004; 23: 132-137.
20. Australian Technical Advisory Group on Immunisation. Clinical advice for immunisation providers regarding the administration of 2015 seasonal influenza vaccines – February 2015. Canberra: Australian Government Department of Health; 2015.
21. Barr IG, Jelley LL. The coming era of quadrivalent human influenza vaccines. Drugs 2012; 72: 2177-2185.
22. Pillsbury A, Quinn HE, McIntyre PB. Australian vaccine preventable disease epidemiological review series: Pertussis, 2006–2012. Commun Dis Intell 2014; 38(3): E179-E194.
23. Quinn HE, Snelling TL, Macartney KK, McIntyre PB. Duration of protection after first dose of acellular pertussis vaccine in infants. Pediatrics 2014; 133: e513-e519.
24. Amirthalingam G, Andrews N, Campbell H, et al. Effectiveness of maternal pertussis vaccination in England: an observational study. Lancet 2014; 384: 1521-1528.
25. Tabrizi SN, Brotherton JM, Kaldor JM, et al. Fall in human papillomavirus prevalence following a national vaccination program. J Infect Dis 2012; 206: 1645-1651.
26. Donovan B, Franklin N, Guy R, et al. Quadrivalent human papillomavirus vaccination and trends in genital warts in Australia: analysis of national sentinel surveillance data. Lancet Infect Dis 2011; 11: 39-44.
27. Crowe E, Pandeya N, Brotherton JM, et al. Effectiveness of quadrivalent human papillomavirus vaccine for the prevention of cervical abnormalities: case-control study nested within a population based screening programme in Australia. BMJ 2014; 348: g1458.

28. Georgousakis M, Jayasinghe S, Brotherton J, Gilroy N, Chiu C, Macartney K. Population-wide vaccination against human papillomavirus in adolescent boys: Australia as a case study. Lancet Infect Dis 2012; 12: 627-634.
29. Naidu L, Chiu C, Habig A, et al. Vaccine preventable diseases and vaccination coverage in Aboriginal and Torres Strait Islander people, Australia 2006–2010. Commun Dis Intell 2013; 37 Suppl: S1-S95.
30. Australian Technical Advisory Group on Immunisation. Clinical advice for immunisation providers regarding the use of Menitorix® in delivering catch-up vaccinations, July 2013. Canberra: Australian Government Department of Health; 2013.
31. Australian Technical Advisory Group on Immunisation. Advice for immunisation providers regarding the use of Bexsero®. Canberra: Australian Government Department of Health; 2014.
32. Gossger N, Snape MD, Yu LM, et al. Immunogenicity and tolerability of recombinant serogroup B meningococcal vaccine administered with or without routine infant vaccinations according to different immunization schedules: a randomized controlled trial. JAMA 2012; 307: 573-582.
33. Blyth CC, Currie AJ, Wiertsema SP, et al. Trivalent influenza vaccine and febrile adverse events in Australia, 2010: clinical features and potential mechanisms. Vaccine 2011; 29: 5107-5113.
34. Buttery JP, Danchin MH, Lee KJ, et al. Intussusception following rotavirus vaccine administration: post-marketing surveillance in the National Immunization Program in Australia. Vaccine 2011; 29: 3061-3066.
35. Macartney KK, Porwal M, Dalton D, et al. Decline in rotavirus hospitalisations following introduction of Australia's national rotavirus immunisation programme. J Paediatr Child Health 2011; 47: 266-270.
36. Arama C, Troye-Blomberg M. The path of malaria vaccine development: challenges and perspectives. J Intern Med 2014; 275: 456-466.
37. Thomas SJ. Preventing dengue – is the possibility now a reality? N Engl J Med 2015; 372: 172-173.
38. Zhu F, Xu W, Xia J, et al. Efficacy, safety, and immunogenicity of an enterovirus 71 vaccine in China. N Engl J Med 2014; 370: 818-828.
39. Broughan J, Anderson R, Anderson AS. Strategies for and advances in the development of Staphylococcus aureus prophylactic vaccines. Expert Rev Vaccines 2011; 10: 695-708.
40. Joura EA, Giuliano AR, Iversen O-E, et al. A 9-valent HPV vaccine against infection and intraepithelial neoplasia in women. N Engl J Med 2015; 372: 711-723.