Communicable Diseases Intelligence

ATAGI Targeted Review 2021: the national COVID-19 vaccination program

Sanjay Jayasinghe, Cyra Patel, Lucy Armstrong, Clayton Chiu, Kristine Macartney, Katie Flanagan, Katherine Gibney, Michelle Giles, Nigel Crawford, Allen Cheng, Chris Blyth on behalf of ATAGI
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Review article

ATAGI Targeted Review 2021: the national COVID-19 vaccination program

Sanjay Jayasinghe, Cyra Patel, Lucy Armstrong, Clayton Chiu, Kristine Macartney, Katie Flanagan, Katherine Gibney, Michelle Giles, Nigel Crawford, Allen Cheng, Chris Blyth on behalf of ATAGI

Abstract

The overarching goal of the Australian coronavirus disease 2019 (COVID-19) vaccination program has been to protect all people in Australia from the harm caused by the novel coronavirus SARS-CoV-2. This review reflects on the role of the Australian Technical Advisory Group on Immunisation (ATAGI) in the national COVID-19 vaccination program, in terms of the initial programmatic and clinical recommendations in the evolving context of evidence relating to the disease and vaccines, epidemiology, and the program rollout. To fulfil the obligation to provide evidence-based advice to the Minister for Health and Aged Care on the safe, effective and equitable use of COVID-19 vaccines, ATAGI has worked closely with other agencies and committees such as the Therapeutic Goods Administration (TGA) and the Communicable Diseases Network Australia. ATAGI recommendations have sought to optimise the use of the available vaccine doses in achieving the objectives of preventing serious illness and death from COVID-19 while addressing any emerging safety signals following program commencement on 22 February 2021. As of mid-November 2021, the use of COVID-19 vaccines in children aged 5 to 11 years was being considered by the TGA and ATAGI; and emerging evidence, in areas such as use of heterologous vaccine schedules and co-administration with other vaccines, was under review. Despite unprecedented challenges which the delivery of mass COVID-19 vaccination presented to health systems globally, in Australia much was achieved in 2021 with over 90% coverage for primary doses in the vaccine-eligible population. Evaluation, using high quality data and assessment methods, of vaccination program outcomes—such as coverage, vaccine effectiveness and impact—is key to determine whether program objectives have been achieved and where gaps remain. Reflecting on the lessons learned so far would help further improve the national COVID-19 vaccination program and would also benefit programs for other routine vaccines and planning for future pandemics.

Introduction

This is the first of a series of targeted reviews from the Australian Technical Advisory Group on Immunisation (ATAGI) on the use of vaccines for the prevention and control of vaccine-preventable diseases. This review focuses on the national coronavirus disease 2019 (COVID-19) vaccination program, particularly the key considerations, including the relevant national and international contexts that underpinned ATAGI’s recommendations.

The COVID-19 pandemic has caused substantial mortality and morbidity globally, disrupting health systems, economic activity and societal function since early 2020. While non-pharmaceutical interventions were used initially with varying degrees of success, a core strategy to manage the acute phase of this pandemic has been population-wide COVID-19 vaccination. COVID-19 vaccines have been developed and brought to market with unprecedented rapidity.

The overarching goal of the Australian COVID-19 vaccination program has been to protect all people in Australia from the harm caused by the novel coronavirus SARS-CoV-2. The program aims have been to reduce COVID-19-related
harm by preventing serious illness and death and, where possible, disease transmission; to ensure equity in vaccine access and uptake; to promote public and health professional trust and confidence in COVID-19 vaccines; and to maintain functioning of healthcare and other essential services.\(^5\)

This review documents ATAGI’s role in Australia’s national COVID-19 vaccination program and key outcomes (as of November 2021), addressing:

- the initial programmatic and clinical recommendations for COVID-19 vaccine use made in the context of evolving information on COVID-19 vaccines (including prioritisation for vaccination considering initial limited vaccine supply);
- the response to safety concerns regarding COVID-19 vaccines;
- the challenges due to factors such as variant viral strains and constraints impacting on required scaling up of program delivery; and
- reflections and considerations relevant to future programmatic decision-making.

Aspects of COVID-19 vaccine program implementation that were outside ATAGI’s remit are not covered in this review.

**Initial planning and implementation of Australia’s COVID-19 vaccination program**

**Governance of the COVID-19 vaccination program in Australia**

The Australian Government’s National COVID-19 Vaccine Taskforce led the rollout of the COVID-19 vaccination program with input from several agencies and advisory committees, including the Therapeutic Goods Administration (TGA), the COVID-19 Vaccines and Treatments Australia – Science and Industry Technical Advisory Group (SITAG), and ATAGI.\(^5\)\(^7\) Other advisory committees established to inform the government’s response to COVID-19 also had input into the COVID-19 vaccine rollout, including on Aboriginal and Torres Strait Islander populations,\(^8\) culturally and linguistically diverse communities,\(^9\) people with disabilities,\(^10\) and aged care.\(^11\)

The ATAGI terms of reference stipulated that the committee was to provide evidence-based advice to the Minister for Health and Aged Care on the safe, effective and equitable use of COVID-19 vaccines.\(^12\) ATAGI has worked in close collaboration with other agencies and committees, notably with the TGA and the Communicable Diseases Network Australia (CDNA), and with invited experts from various clinical fields, including groups commissioned by the Department of Health and Aged Care to model COVID-19 vaccination strategies.

A timeline of the key events of the COVID-19 vaccination program in Australia is shown in Figure 1.

**Prioritising the allocation of COVID-19 vaccines**

Initial planning for the rollout of COVID-19 vaccines in Australia predominantly involved ATAGI identifying which population groups should be prioritised,\(^5\) given the expected initial limited global and national supply of vaccines. Several COVID-19 vaccination allocation and prioritisation frameworks were consulted, particularly the WHO Strategic Advisory Group of Experts on Immunization (SAGE)\(^13\) and the National Academy of Sciences\(^14\) frameworks, both of which highlighted key ethical principles for equitable vaccine allocation. Recommendations about vaccine prioritisation were based on:

- epidemiological evidence on which population groups were at highest risk of exposure to SARS-CoV-2 or of becoming seriously ill or of dying from COVID-19;
- operational considerations, particularly vac-
Figure 1: The timeline of the Australian COVID-19 vaccination program

<table>
<thead>
<tr>
<th>Program Milestones</th>
<th>Vaccine Rollout Phases (commencement date)</th>
<th>TGA Key Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 November 2020</td>
<td>22 February 2021: Program Commenced</td>
<td>25 January 2021</td>
</tr>
<tr>
<td>Australian COVID-19 vaccination policy published</td>
<td>ATAGI (Australian Technical Advisory Group)</td>
<td>Comirnaty provisionally registered for ≥16 years</td>
</tr>
<tr>
<td>7 January 2021</td>
<td>30 August 2021</td>
<td>16 February 2021</td>
</tr>
<tr>
<td>Australia’s COVID-19 vaccine national roll-out strategy published</td>
<td>Vaccine eligibility use of Comirnaty</td>
<td>Vaxzevria provisionally registered for ≥18 years</td>
</tr>
<tr>
<td>22 February 2021</td>
<td>3 May 2021</td>
<td>22 January 2021</td>
</tr>
<tr>
<td>Use of Comirnaty commenced (≥16 years)</td>
<td>Vaccine eligibility use of Vaxzevria</td>
<td>Comirnaty provisionally registered for ≥12 years</td>
</tr>
<tr>
<td>8 March 2021</td>
<td>8 June 2021</td>
<td>16 February 2021</td>
</tr>
<tr>
<td>Use of Vaxzevria commenced (≥18 years)</td>
<td>Vaccine eligibility use of Comirnaty in ≥30 years</td>
<td>Vaccine eligibility use of Spikevax in ≥12 years</td>
</tr>
<tr>
<td>3 May 2021</td>
<td>30 August 2021</td>
<td>22 July 2021</td>
</tr>
<tr>
<td>Vaccine eligibility expanded to ≥30 years</td>
<td>Vaccine eligibility use of Comirnaty in ≥12 years</td>
<td>Spikevax provisionally registered for ≥12–17 years</td>
</tr>
<tr>
<td>8 June 2021</td>
<td>13 September 2021</td>
<td>9 August 2021</td>
</tr>
<tr>
<td>Vaccine eligibility expanded to ≥60 years</td>
<td>Vaccine eligibility use of Comirnaty in ≥18 years</td>
<td>Spikevax provisionally registered for ≥18 years</td>
</tr>
<tr>
<td>30 August 2021</td>
<td>8 November 2021</td>
<td>9 August 2021</td>
</tr>
<tr>
<td>Vaccine eligibility use of Spikevax commenced (≥12 years)</td>
<td>Spikevax provisionally registered for ≥18 years</td>
<td>Booster dose of Comirnaty recommended for ≥18 years</td>
</tr>
<tr>
<td>8 November 2021</td>
<td></td>
<td>28 October 2021</td>
</tr>
<tr>
<td>COVID-19 booster vaccine program commenced</td>
<td></td>
<td>Booster dose of Comirnaty recommended for adults ≥18 years, eligibility 6 months post dose 2</td>
</tr>
<tr>
<td></td>
<td>22 February 2021</td>
<td>28 October 2021</td>
</tr>
<tr>
<td>ATAGI COVID-19 Working Group and subgroups established</td>
<td>Phase 1a: (22 Feb 2021)</td>
<td>Booster dose of Comirnaty recommended for children aged 12–15 years at high risk* and in remote communities</td>
</tr>
<tr>
<td>November 2020</td>
<td>Phase 1b: (22 March 2021)</td>
<td>27 August 2021</td>
</tr>
<tr>
<td>Preliminary prioritisation advice developed</td>
<td>Phase 2a: (3 May 2021)</td>
<td>Comirnaty and Spikevax recommended for all 12–17 years</td>
</tr>
<tr>
<td>December 2020</td>
<td>Phase 2b: (30 August 2021)</td>
<td>8 October 2021</td>
</tr>
<tr>
<td>Prioritisation advice updated</td>
<td>Phase 3: (13 September 2021)</td>
<td>Third primary dose of COVID-19 vaccine recommended for individuals severely immunocompromised</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 October 2021</td>
</tr>
<tr>
<td></td>
<td>25 January 2021</td>
<td>Booster dose of Comirnaty recommended for adults ≥18 years, eligibility 6 months post dose 2</td>
</tr>
<tr>
<td></td>
<td>16 February 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vaccine eligibility use of Vaxzevria in adults aged &lt;50 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 April 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comirnaty preferred over Vaxzevria in adults aged &lt;50 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>23 May 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint statement with THANZ on TTS and the use of Vaxzevria released</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 June 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joint statement with RANZCOG on COVID-19 vaccination for pregnant women released</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 June 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comirnaty preferred over Vaxzevria in adults aged &lt;60 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 July 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advice on COVID-19 vaccine use in outbreak settings published</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 July 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COVID-19 vaccine (incl. Vaxzevria) use recommended for ≥18 years in response to outbreaks in NSW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30 July 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guidance on myocarditis and pericarditis after mRNA COVID-19 vaccines developed by CSANZ, RACGP, ACRRM &amp; ACEM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 August 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comirnaty recommended for children aged 12–15 years at high risk* and in remote communities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>27 August 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comirnaty and Spikevax recommended for all 12–17 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 October 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third primary dose of COVID-19 vaccine recommended for individuals severely immunocompromised</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28 October 2021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Booster dose of Comirnaty recommended for adults ≥18 years, eligibility 6 months post dose 2</td>
<td></td>
</tr>
</tbody>
</table>

**National Vaccination Coverage %† (as at end of month):**

Age ≥16 yrs, age 12-15 yrs †

<table>
<thead>
<tr>
<th>Age ≥16 yrs, age 12-15 yrs</th>
<th>National Vaccination Coverage %†</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥16 yrs</td>
<td>40.5,D2:18.8</td>
</tr>
<tr>
<td>12–15 yrs</td>
<td>18.8,D2:0.7</td>
</tr>
</tbody>
</table>


**Source:** COVID-19 vaccination daily rollout update, Australian Government Department of Health

**ATAGI:** Australian Technical Advisory Group on Immunisation; **THANZ**: Thoracic and Haematologic Society of Australia and New Zealand; **RANZCOG**: Royal Australian and New Zealand College of Obstetricians and Gynaecologists; **CSANZ**: Cardiac Society of Australia and New Zealand; **RACGP**: Royal Australian College of General Practitioners; **ACRRM**: Australian College of Rural and Remote Medicine; **ACEM**: Australasian College of Emergency Medicine

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**Note:** This data is sourced from the Australian Government Department of Health and is accurate as of the publication date. It is subject to change as further information becomes available.
cine supply and distribution (as advised by the National COVID-19 Taskforce); and

- social and economic considerations such as protecting critical sectors (eg: health and other essential services).

Australia’s strong pandemic response, using public health measures such as test-trace-isolate-quarantine (TTIQ) protocols and border measures, resulted in a substantially lower burden of COVID-19 in Australia in 2020 than was observed globally. The first wave of infections in Australia (between January and June 2020) was characterised by international importation of SARS-CoV-2 (63% of all confirmed cases during this period). Although outbreaks were limited in scale, some resulted in more widespread transmission, including across multiple states. There were 7,489 confirmed cases to 9 June 2020, although serosurveys suggest SARS-CoV-2 transmission was likely higher. The second period (10 June to 13 October 2020) was dominated by the large Victorian outbreak of 18,504 cases, with 99.6% of cases locally acquired. Over 2,000 cases occurred within residential aged care facilities.

Healthcare workers comprised a substantial proportion of cases (approximately 17.5%), and were three times more likely to acquire infection than were non-healthcare workers.

ATAGI recommendations in December 2020, regarding initial priority population groups for vaccination (Box 1), were made in the setting of no to minimal community transmission. It was anticipated that modifications may be required in response to emerging changes in epidemiology or to the evidence on vaccine efficacy and safety. ATAGI recommended that robust modelling be undertaken, examining a range of vaccination strategies on health outcomes under different scenarios and assumptions on vaccine characteristics, to guide the optimal COVID-19 vaccination rollout over time.

ATAGI identified Aboriginal and Torres Strait Islander populations as a priority, noting that any vaccination strategy for this population must be developed in consultation with the National Aboriginal Advisory group and all other relevant stakeholders. A list of conditions associated with increased risk of COVID-19 severe disease and mortality was also developed in consultation with other specialist groups.

Box 1: ATAGI’s recommendations in December 2020 for priority groups for COVID-19 vaccine allocation

First recipients of COVID-19 vaccines should include:

1. Staff at entry points to the country and in quarantine facilities; and

2. Healthcare workers at increased risk or likelihood of exposure to persons infected with SARS-CoV-2. This includes those in healthcare facilities, services, or settings where patients with COVID-19 or suspected COVID-19 may present and patients with confirmed COVID-19 are managed.

Subsequent populations for vaccination, in recommended order, include:

- Staff and residents of care facilities;
- Elderly adults aged 70 years and over; and
- Staff in remaining health care settings.

At the time, there was insufficient information to advise on the order of priority for the remaining populations below:

- Older adults aged 60–69 years;
- Aboriginal and Torres Strait Islander adults;
- Adults (< 60 years old) with underlying
Registration of COVID-19 vaccines and commencement of the program

Comirnaty (Pfizer) was the first COVID-19 vaccine to be granted TGA provisional registration, on 25 January 2021, for use in individuals 16 years of age and older. Vaxzevria (AstraZeneca) was granted provisional registration on 16 February 2021, for use in individuals 18 years of age and older. ATAGI’s clinical guidance for use of COVID-19 vaccines in Australia was based on interim analyses of phase 2/3 trials and on emerging real-world evidence from countries which had already started to use the vaccines. Supplementary statements for specific groups (such as pregnant women) and decision guides were published subsequently.

The Australian national COVID-19 vaccination program commenced on 22 February 2021, in phases based on priority groups as determined by the Australian Government incorporating ATAGI advice (Figure 2). From March 2021, there was a steady supply of locally-manufactured Vaxzevria.

Challenges faced during the COVID-19 vaccination program in Australia

Over the course of the vaccination program various challenges arose, including changes in the local epidemiology of COVID-19, detection of safety signals, and emerging virus variants. The limited supply of COVID-19 vaccine, particularly Comirnaty, in the first six months of the program compounded these challenges.

A new clinical condition, thrombosis and thrombocytopenia syndrome (TTS) following Vaxzevria vaccination, emerged as a safety signal in March 2021. The European Medicines Agency (EMA) and their Pharmacovigilance Risk Assessment Committee (PRAC) reviewed thromboembolic events following COVID-19 vaccine receipt after a person in Austria was diagnosed with thrombosis at multiple anatomical sites and died ten days after vaccination. ATAGI issued a statement on 19 March 2021, following the review of TTS data from Europe and the EMA preliminary assessment, highlighting that the benefits of vaccination using Vaxzevria outweighed any risk of side effects. As a precautionary measure, on 25 March, ATAGI advised health care providers to defer vaccination with any COVID-19 vaccine in people with a confirmed medical history of cerebral venous sinus thrombosis (CVST) or heparin-induced thrombocytopenia (HIT).

TGA received the first report of a local TTS case on 2 April 2021. On 8 April 2021, ATAGI recommended that Comirnaty be preferred over Vaxzevria in adults aged under 50 years, for whom the risk of severe COVID-19 was lower, and the risk of TTS was considered higher, than for those in older age groups. However, ATAGI also emphasised that Vaxzevria should be considered for adults under 50 years where the benefits outweighed the risks and where the person had made an informed decision. At the time, studies suggested an overall rate of TTS of approximately 4–6 per million occurring 4 to 20 days after the first dose of Vaxzevria, and in the United Kingdom (UK) overall mortality of 25%, with some variability seen in TTS rates across settings. In the UK, the reported rate of TTS in those aged 50–59 years was 4 per million doses. A resource was developed, comparing the benefits of vaccination with the risk of TTS in various epidemiologic scenarios, to guide informed decisions about receiving Vaxzevria.
Figure 2: Phases of the COVID-19 vaccine national rollout strategy, as published at commencement of the national program\(^a\)\(^b\)

<table>
<thead>
<tr>
<th>Phase 1a – up to 1.4m doses</th>
<th>Phase 1b – up to 14.8m doses</th>
<th>Ongoing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarantine and border workers</td>
<td>Elderly adults aged 80 years and over</td>
<td>1,045,000</td>
</tr>
<tr>
<td>Frontline health care worker sub-groups for prioritisation</td>
<td>Elderly adults aged 70–79 years</td>
<td>1,858,000</td>
</tr>
<tr>
<td>Aged care and disability care staff</td>
<td>Other health care workers</td>
<td>953,000</td>
</tr>
<tr>
<td>Aged care and disability care residents</td>
<td>Aboriginal and Torres Strait Islander people &gt; 55 years</td>
<td>87,000</td>
</tr>
<tr>
<td>Total</td>
<td>Younger adults with an underlying medical condition, including those with a disability</td>
<td>2,000,000</td>
</tr>
<tr>
<td></td>
<td>Critical and high risk workers including defence, police, fire, emergency services and meat processing</td>
<td>196,000</td>
</tr>
<tr>
<td>Total</td>
<td>6,139,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2a – up to 15.8m doses</th>
<th>Phase 2b – up to 16m doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults aged 60-69 years</td>
<td>Adults aged 50-59 years</td>
</tr>
<tr>
<td>2,650,000</td>
<td>3,080,000</td>
</tr>
<tr>
<td>Aboriginal and Torres Strait Islander people 18-54</td>
<td>Balance of adult population</td>
</tr>
<tr>
<td>387,000</td>
<td>6,643,000</td>
</tr>
<tr>
<td>Other critical and high risk workers</td>
<td>Catch up any unvaccinated Australians from previous phases</td>
</tr>
<tr>
<td>453,000</td>
<td>&lt; 18 if recommended</td>
</tr>
<tr>
<td>Total</td>
<td>5,670,000</td>
</tr>
</tbody>
</table>

Population numbers are current estimates for each category.


\(^b\) Numbers in the tables indicate the estimated size of eligible population groups in each phase.
ATAGI established weekly meetings from 28 April 2021 with the full ATAGI membership, to review emerging safety data on TTS from the TGA and from other countries (including liaising directly with international regulators and committees), and began publishing a weekly statement summarising deliberations. ATAGI published a joint statement with the Thrombosis and Haematosis Society of Australia and New Zealand (THANZ) on the use of Vaxzevria, including an expanded list of conditions for which Comirnaty was preferred. The comprehensive review of emerging safety data led ATAGI to revise the age limit below which the preferred vaccine was Comirnaty, from 50 years to 60 years, on 17 June 2021. At this stage, the incidence and severity of TTS following Vaxzevria vaccination, reported through national adverse event surveillance systems among people aged 50 to 59 years, was higher than that reported internationally and was also higher than the incidence initially estimated in Australia (increasing from 19 to 27 per million first doses of Vaxzevria). Similar vaccine preferences, based on age and risk-assessment, had been issued in several other countries from March 2021 onwards.

The occurrence of TTS adversely impacted the Australian public’s confidence in COVID-19 vaccines, with cross-sectional surveys indicating that the proportion of the population willing to receive a COVID-19 vaccine had declined from 80% in February 2021 to 68% in April 2021. Repeat surveys found increasing reluctance to receive Vaxzevria from April onwards, with the proportion of people stating that they were willing to receive Comirnaty but not Vaxzevria increasing from 28% in April to 30% in June, to 42% in July and to 47% in August. These surveys were conducted at a time when there was low to moderate local transmission of SARS-CoV-2 but during which supply of Pfizer vaccine was limited.

**Vaccine use in outbreak settings**

In mid-June 2021, a large outbreak of the more transmissible SARS-CoV-2 Delta variant in Metropolitan Sydney began and soon spread to regional NSW and Melbourne. In response to increasing community-based transmission of SARS-CoV-2 in these settings, on 13 July ATAGI reassorted the importance of the benefits over risk of using Vaxzevria among younger adults aged 18–59 years in outbreak areas, and broadly where Comirnaty was not immediately accessible. The recommended interval between Vaxzevria doses was also shortened from 12 weeks to 4–8 weeks, to more rapidly achieve two-dose protection based on higher vaccine effectiveness observed against the Delta variant with two doses than with one dose (Table 1). On 24 July, ATAGI reiterated that all individuals aged ≥ 18 years in Greater Sydney should strongly consider vaccination with any available vaccine, including Vaxzevria. Flexibility in the interval between Comirnaty doses was recommended, as an interval of 6 weeks would allow limited vaccine supplies to be redirected to provide higher dose 1 uptake among affected areas to help mitigate against transmission.

**Table 1: Estimates of vaccine effectiveness of Vaxzevria which ATAGI considered in developing advice supporting a shorter interval between doses in settings of outbreaks caused by the Delta variant**

<table>
<thead>
<tr>
<th>Number of doses</th>
<th>Endpoint</th>
<th>VE* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two</td>
<td>Symptomatic laboratory-confirmed COVID-19</td>
<td>67% (61–72%)</td>
</tr>
<tr>
<td></td>
<td>Hospitalisation</td>
<td>92% (75–97%)</td>
</tr>
<tr>
<td>One</td>
<td>Symptomatic laboratory-confirmed COVID-19</td>
<td>30% (24–35%)</td>
</tr>
<tr>
<td></td>
<td>Hospitalisation</td>
<td>71% (51–83%)</td>
</tr>
</tbody>
</table>

* Based on the United Kingdom study (July 2021) by Stowe et al.
* Vaccine effectiveness.
* 95% confidence interval.
Myocarditis and pericarditis after mRNA COVID-19 vaccines

In June 2021, an emerging safety signal of myocarditis and pericarditis following mRNA COVID-19 vaccines was detected, particularly among young adult males after their second dose of mRNA vaccines. In initial data from Israel, Europe, and the United States of America (USA), where mRNA vaccines were extensively used, the crude rates of myocarditis or pericarditis per million second doses of vaccines in people aged 12–29 years were 40.6 in males and 4.2 in females. Following a comprehensive review, ATAGI and the Cardiac Society of Australia and New Zealand (CSANZ) jointly developed guidance on myocarditis and pericarditis after mRNA vaccines, published on 30 July 2021, recognising these conditions as a complication of COVID-19 mRNA vaccines, as well as from COVID-19 itself, and that the risk to benefit ratio remained overwhelmingly in favour of vaccination. The statement included recommendations for subsequent COVID-19 vaccine doses in individuals who had this adverse event following immunisation. The joint statement was updated later with input from the Royal Australian College of General Practitioners (RACGP), the Australian College of Remote and Rural Medicine (ACRRM) and the Australasian College of Emergency Medicine (ACEM).

COVID-19 vaccine use in pregnancy

At the beginning of the vaccine roll-out, the initial ATAGI position was that COVID-19 vaccine was not routinely recommended in pregnancy due particularly to lack of specific safety data. However, vaccination was recommended to be considered if the potential benefits of vaccination outweighed any potential harms such as in the presence of medical risk conditions for severe COVID-19 and being at high risk of exposure to SARS-CoV-2. In subsequent months, global surveillance data became available on COVID-19 use in large numbers of pregnant women; this surveillance data did not identify any significant safety concerns with mRNA COVID-19 vaccines given at any stage of pregnancy. There was also evidence of antibodies in cord blood and breastmilk, which may offer protection against SARS-Cov-2 to infants through passive immunity. Additionally, there was clear evidence that the risk of severe outcomes from COVID-19 was significantly higher for pregnant women and their unborn babies.

A review of these data was undertaken by ATAGI and the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG), with publication of a joint statement, in June 2021, recommending that pregnant women be routinely offered Comirnaty at any stage of pregnancy.

Expansion of the program to young adolescents

On 23 July 2021, TGA’s provisional registration of Comirnaty was extended to include all people from 12 years of age (from age ≥ 16 years previously). ATAGI initially recommended that Comirnaty be offered to children aged 12–15 years who had underlying medical conditions that increased their risk of COVID-19, who were Aboriginal and Torres Strait Islander children, or who lived in remote communities. From 27 August 2021, ATAGI recommended Comirnaty for all individuals from 12 years of age. Efficacy data for Comirnaty in the phase 3 trial, with over 2,000 participants aged 12–15 years, was 100% (95% CI: 78–100%). There was a good safety profile, similar to that in young adults, reported in the trial and also from safety surveillance overseas in countries which had already implemented an adolescent program.

Spikevax (Moderna) was provisionally registered for use on 9 August 2021, initially for individuals aged ≥ 18 years, and extended to 12–17 year olds on 4 September 2021. The delivery of COVID-19 vaccine to adolescents via a school program was considered but was assessed as unfeasible, at the time, due to several potential implementation challenges such as limited workforce capacity; interference with routine school vaccination program; missing those children not in school; and school closures in states.
with ongoing outbreaks. Therefore, the delivery of vaccination to adolescents occurred using the same settings as for adults. Uptake of COVID-19 vaccine in adolescents was swift, with 35% in the 12 to 15 years age group receiving the first dose in the first two weeks of the program (to 30 September 2021). ATAGI has continued to monitor the safety of Comirnaty and Spikevax in adolescents, including review of data in Australia and other countries on the occurrence of myocarditis/pericarditis in this age group. The emerging local data and international data on these adverse events across all age groups were reviewed in ATAGI weekly meetings to determine whether any changes in recommendations were warranted. Ongoing monitoring of COVID-19 epidemiology and emerging data on vaccine effectiveness evaluations were also reviewed as standard agenda items in weekly ATAGI meetings.

Challenges to scaling up program delivery

The scale of the program, constraints on workforce capacity, and distribution and access logistics were key challenges to delivering mass COVID-19 vaccination. The program was initially envisaged to be delivered primarily through the existing primary care system, particularly general practice (GP) clinics and Aboriginal and Torres Strait Islander Community Controlled Health sector services, supplemented by on-site delivery in aged care facilities and more broadly dedicated mass vaccination clinics established by state and territory health departments. Once vaccines were locally available, mass vaccination hubs established by states and territories, in combination with GPs, successfully helped to build the program quickly. Vaccination locations were also expanded to pharmacies, particularly when Spikevax became available in September 2021.

As vaccine supply improved, outreach clinics were used increasingly to address access barriers. Following relevant advice from ATAGI, mobile vaccination hubs and drive-through vaccination clinics were established. By this stage of the program, new information on more flexible storage and handling requirements for COVID-19 vaccines, particularly regarding thermostability, became available; this enabled easier cold chain management, assisting in transportation of vaccines. The program scaled up considerably from approximately August 2021: by the end of September 2021, more than 300,000 vaccine doses were being administered daily. Vaccine uptake nationally reached 92.4% for at least one dose and 87.0% for two doses among people aged ≥ 16 years as of 30 November 2021. Among adolescents aged 12–15 years, the coverage estimates at this time were 76% for dose 1 and 66% for dose 2.

Future directions for the COVID-19 vaccination program

Some of the key areas for consideration in the coming months are upscaling the booster vaccine program (as progressively more people become eligible), use of heterologous vaccine schedules, co-administration with other vaccines, and vaccination of children younger than 12 years, as well as consideration of new COVID-19 vaccines.

Booster doses and three-dose primary courses

Since July 2021, several countries commenced booster vaccination for older and at-risk individuals prior to the northern hemisphere winter season. Observational study data (predominantly for Comirnaty, Spikevax and Vaxzevria) suggests that vaccine protection against severe outcomes of COVID-19 (i.e. hospitalisations, ICU admissions and deaths) following two doses of COVID-19 vaccine is maintained for at least six months including against the Delta variant. There is, however, evidence that some severely immunocompromised people have a decreased immune response to COVID-19 vaccination that translates to lower vaccine effectiveness. A third primary dose of
COVID-19 vaccine in severely immunocompromised individuals was recommended by ATAGI on 8 October 2021.81

Following TGA provisional registration of the booster dose of Comirnaty for individuals aged ≥ 18 years, ATAGI supported the use of a single booster dose for those who had completed their primary COVID-19 vaccine course at least six months earlier. The program commenced on 8 November 202182 and, while open to all adults, the groups prioritised for vaccination in the early stages of the program would become eligible first.83

Use of mixed schedules

The evidence on the effectiveness of schedules using heterologous primary or booster COVID-19 vaccine doses is still evolving. Early evidence shows increased immunogenicity in mixed schedules when a first dose of Vaxzevria is followed by Comirnaty,84 although some data suggest higher reactogenicity.85 Some overseas countries permit heterologous schedules for booster doses,86 while some preference the use of an mRNA vaccine to complete a schedule where Vaxzevria was the first dose.87 These data are informing advice on use of a mixed primary schedule, such as those who have had a serious adverse reaction to their first dose of vaccine or returning travellers who have had a first dose of vaccine not available in Australia, and considerations for the use of booster doses.22

Co-administration of COVID-19 vaccines with other vaccines

Due to the absence of information on the safety and efficacy of COVID-19 vaccines with other vaccines, ATAGI initially recommended maintaining a 14-day interval between receipt of vaccines,88 which was later reduced to seven days. However, overseas countries routinely permitted co-administration in all age groups.89,90 Evidence indicates that co-administering Comirnaty, Vaxzevria and Novavax COVID-19 vaccine with influenza vaccine is safe and immunogenic.91,92 Additional trials of co-administration with influenza93,94 and pneumococcal vaccines85 were underway at the time of writing this review. In October 2021, ATAGI revised its advice to permissive recommendation of concomitant administration of COVID-19 vaccines with any other vaccine due at the same time.

Vaccination of children aged < 12 years

As of mid-November 2021, the use of Comirnaty in children aged 5 to 11 years was under review by the TGA and ATAGI. Its use in this age group commenced in late 2021 in USA96 using a smaller dose of 10 μg of mRNA (compared with 30 μg for people aged ≥ 12 years). A phase 3 clinical trial of approximately 2,000 children aged 5–11 yrs reported vaccine efficacy to be 90.7% (95% CI: 67.7–98.3%).97 While initial data appear to support a good safety profile of Comirnaty in this age group, careful assessment of risks and benefits of vaccination is needed given the relatively lower burden of acute COVID-19 disease among young children and absence of data on myocarditis risk following vaccination in this age group. Trials of Spikevax and Vaxzevria in children < 12 years of age were underway at the time of writing this review.98,99

Evaluation of the COVID-19 vaccination program

Independent monitoring and evaluation are critical elements of immunisation programs that guide program implementation and ensure accountability and transparency.100 Of note, ATAGI has been provided with regular information on program implementation, coverage and uptake, specifically in special risk groups as available. Evaluation of program outcomes such as coverage, vaccine effectiveness and the impact on the burden of COVID-19, based on high quality data and study methods including data linkage, is key to determine whether program goals have been achieved and where gaps remain. Ongoing monitoring of vaccine confidence and community experiences with accessing vaccines and barriers to uptake will assist in further improving coverage, particularly in
populations where hesitancy and access inequality have been experienced and who are priority populations for vaccination. Serological surveys will provide long-term validation of coverage and ongoing population susceptibility. A performance audit by the Australian National Audit Office (ANAO), that was underway at the time of writing this review, would examine the planning and the implementation of the entire national COVID-19 vaccination program including the governance arrangements established to manage the rollout.101

Reflections

COVID-19 and delivery of mass COVID-19 vaccination presented an unprecedented challenge for health systems globally. In Australia despite these challenges, much has been achieved thus far as of November 2021 with over 90% COVID-19 vaccine two-dose coverage in the vaccine-eligible population ≥ 12 years within reach. Achieving high uptake of vaccines among adults has been an ongoing challenge. The experience of delivering COVID-19 vaccines has also provided insights into how to effectively target, reach and communicate with adults about vaccination. New legislation mandating reporting of most vaccines to the Australian Immunisation Register102 will lead to improved ascertainment of coverage of adulthood vaccines. Pharmacovigilance and vaccine safety surveillance systems have been rigorously tested emphasising the need to communicate carefully on benefits and risks. Collaborations across medical disciplines and with networks and leadership groups representing priority populations have been strengthened. The engagement with external policy settings and contexts has ongoing implications for workforce, training, models of vaccine delivery and COVID-19 control in the regional setting. The overall low level of COVID-19 disease in 2020 and 2021 in Australia, also meant that a number of other countries had priority with regards to vaccines that were a scare resource in early 2021 while the global access via the COVAX initiative remained a work in progress.

On the other hand, the initial reliance of Australia’s program on Vaxzevria as the main vaccine brand, and the unexpected safety issues associated with its use, limited the ability to rapidly scale up vaccine delivery, particularly in the first six months of the program. Some elements of the national rollout plan, including adherence to the initial prioritisation framework, were not well achieved, with low uptake among the Aboriginal and Torres Strait Islander population, the disability sector and aged-care facilities early in the program. Balancing ATAGI’s key role in comprehensive review of emerging data, being transparent with the public about emerging safety signals, and maintaining confidence in vaccination proved to be a significant challenge. On reflection, alternative language and communication strategies, particularly with communities at highest risk, may have conveyed the information effectively but with less impact on vaccine confidence. The need for continual assessment and improvement of program performance and agility in responding to challenges was reflected in the renewed COVID-19 vaccination plan, Operation COVID Shield.103 Documenting the lessons learned, and using the insights to drive changes in the governance and implementation of vaccine programs, can potentially improve the uptake of COVID-19 vaccines, other routine vaccines, and vaccines required in future pandemics.
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References


9. Australian Government Department of Health and Aged Care. Culturally and Linguistically Di-


