Data sources/assumptions/prior distributions informing a Bayesian network to assess six-month long COVID probability in Australia

Model inputs	Data sources, assumptions, rationale (references)
Sex and Age group	Proportions of the Australian adult population falling into each age and sex category were extracted from the June 2021 Australian Bureau of Statistics National State and Territory Population Report[1]. See Supplementary Table 1. Children were excluded from the model due to incomplete or inconsistent data availability at the time of development.
Number of comorbidities	Proportions of the Australian adult living with zero, one, two, or three or more comorbidities were found from the Australian Bureau of Statistics AUSSTATS Report[2]. To fit this data to the model categories of zero, one, two, three, or four or more, it was assumed that the category 'three or more' consisted 50% of people experiencing three comorbidities and 50% of people experiencing four or more comorbidities. See Supplementary Table 2. By reporting number of comorbidities only, the model assumes an equal risk for each comorbidity.
Infection number	Proportions of the Australian adult population suffering from first, second and third plus infections were not available, so data were drawn from the UK Government Coronavirus database[3]. These data were assumed to be applicable to the Australian population due to similar dates of oncoming strain waves and similar public healthcare scenarios. Data reported the proportions of total infections that were first or reinfections. To fit model categories of first, second, or third plus infections it was assumed that there would be the same ratio of third to second infections as for second to first. See Supplementary Table 3.
Vaccine dose & timing	Proportions of the Australian adult who were unvaccinated, or had received their last vaccine dose less than six months or six months or more ago were extracted from the May 2023 Australian Government COVID-19 Vaccine Report[4]. To fit the model categories of dose number and timing it was assumed that these numbers were evenly split across all categories of dose number and timing. See Supplementary Table 4.
Drug treatment	Proportions of individuals suffering from COVID-19 who receive acute treatment in Australia were not available. Therefore, the model adopts a prior distribution of even likelihood of receiving no treatment, or receiving molnupiravir (within first five days of testing), metformin (1500mg immediate release taken over six days) within 7 days of symptom onset, metformin (1500mg immediate release taken over six days) within three days of symptom onset, or nirmatrelvir (Paxlovid) (within first five days of testing). Public health analyses within this work have selected the option of 'no medication' unless otherwise specified, as most cases go untreated. See Supplementary Table 5.
Risk of symptomatic infection	Risk of symptomatic infection was set to 1.0 to ensure risk estimates within the model pertain to a scenario in which one is already symptomatically infected.
Vaccine effectiveness	Data on vaccine effectiveness against hospitalisation and ICU admission were drawn from the UK Government's Vaccine Surveillance Report Week 14 2023[5]. Incomplete vaccination (one dose only) was assumed to be ineffective. When data were presented in smaller

against hospitalisation and ICU admission	time categories than presented in the model, data were averaged to received estimated particular to the model time-points. Data pertaining to the fourth dose were presented as relative to protection from a third dose received 25-39 weeks ago; calculations using the provided estimate of 52.6% were made to achieve an estimate of unrelative vaccine effectiveness. Insufficient data were available at the time of model development to include possible effects of comorbidities on vaccine effectiveness. See Supplementary Table 4.
Hospitalisation	To achieve estimates of case numbers for symptomatic COVID-19 cases from omicron variants requiring hospitalisation within Australia, and to keep separate the effects of vaccination, data on unvaccinated, hospitalised cases between 26/11/21 and 05/02/22 were drawn from the New South Wales (NSW) COVID-19 Surveillance Reports[6]. These proportions were then applied to the Australian population, assuming an equal proportion of hospitalisations throughout Australia as in NSW. Data were manipulated to provide estimates for age categories displayed within the model. As data were taken from population estimates, the effect of comorbidity number on hospitalisation risk is assumed to be integrated. Data on effects of repeat infection on hospitalisation risk were drawn from published research using the US Department of Veterans Affairs national healthcare databases[7]; the model thus operates under the assumption that these data may apply more broadly to the Australian population. Data on effects of each treatment option on reducing the risk of hospitalisation from COVID-19 were drawn from published literature[7,8,9,10]. See Supplementary Table 6.
ICU admission	To achieve estimates of case numbers for symptomatic COVID-19 cases from omicron variants requiring ICU admission within Australia, and to keep separate the effects of vaccination, data on unvaccinated, ICU-admitted cases between 26/11/21 and 05/02/22 were drawn from the New South Wales (NSW) COVID-19 Surveillance Reports[6]. These proportions were then applied to the Australian population, assuming an equal proportion of ICU admissions throughout Australia as in NSW. Data were manipulated to provide estimates for age categories displayed within the model. As data were taken from population estimates, the effect of comorbidity number on ICU admission risk is assumed to be integrated. Data on effects of repeat infection on ICU admission risk were drawn from published research using the US Department of Veterans Affairs national healthcare databases[7]; the model thus operates under the assumption that these data may apply more broadly to the Australian population. This assumption is justified and conservative based on results from other published literature[11]. Data on effects of each treatment option on reducing the risk of ICU admission from COVID-19 were drawn from published literature[8,9,10]. See Supplementary Table 6.
Vaccine effectiveness against death if infected	Data on vaccine effectiveness against death were drawn from the UK Government's Vaccine Surveillance Reports Weeks 5, 14, and 24, 2023[5,12,13]. Incomplete vaccination (one dose only) was assumed to be ineffective. When data were presented in smaller time categories than presented in the model, data were averaged to received estimated particular to the model time-points. Insufficient data were available at the time of model development to include possible effects of comorbidities on vaccine effectiveness. See Supplementary Table 4.
Die from COVID-19	To achieve estimates of case numbers for symptomatic COVID-19 cases from omicron variants ending in mortality within Australia, and to keep separate the effects of vaccination, data on unvaccinated, COVID-19 fatalities between 26/11/21 and 05/02/22 were drawn from the New South Wales (NSW) COVID-19 Surveillance Reports[6]. These proportions were then applied to the Australian population,

	assuming an equal proportion of deaths throughout Australia as in NSW. Data were manipulated to provide estimates for age categories displayed within the model. As data were taken from population estimates, the effect of comorbidity number on mortality risk is assumed to be integrated. Data on effects of repeat infection on mortality risk were drawn from published research using the US Department of Veterans Affairs national healthcare databases[7]; the model thus operates under the assumption that these data may apply more broadly to the Australian population. Data on effects of each treatment option on reducing the risk of death from COVID-19 were drawn from published literature[8,9,10]. Data pertaining to metformin were on reducing risk of hospitalisation or death; it has been assumed this data is acceptable to use as the protection of the treatment again death alone may be estimated to be higher. See Supplementary Table 6.
Long COVID outcomes	Data on the effects of vaccination status[14], infection number[7], hospitalisation status, age, sex, and number of comorbidities[15] on six-month risks of long COVID outcomes affecting different organ systems were drawn from three published studies performed by Ziyad Al-Aly et al. using the US Department of Veterans Affairs national healthcare databases. Use of these three studies in combination allowed for seamless integration of all of these many effects on risk and negated the need to make assumptions to achieve estimates for the chosen model timepoint, as all studies reported risks at six months post-infection. However, this data is limited by describing a skewed population of 90% men with an average age of 61 years – consequently, the model relies on the assumption that these estimates are applicable to the broader population. Data on effects of each treatment option on reducing the risk of long COVID were drawn from published literature[8,9,10]. See Supplementary Table 7.

Supplementary Table 1. Sex and age group as percentage of the Australian adult population[1]

Age group	Male	Female
18-60	36.86%	35.86%
61-70	6.56%	6.73%
71+	6.58%	7.42%

Supplementary Table 2. Comorbidity number frequency as percentage of sex-age groups[2]

Age		18–60		61–70		71+	
Sex		**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Comorbidity number	**0**	55.41%	51.57%	24.85%	23.00%	13.60%	13.50%
	1–3	41.57%	44.47%	68.80%	68.50%	71.75%	72.25%
	4+	3.02%	3.96%	6.35%	8.50%	14.65%	14.25%

Supplementary Table 3. Proportion of Australian population estimated to suffer from first, second or third plus SARS-CoV-2 infections[3]

Infection number	Case number	Percentage of total
1st infection	21,053,675	94.66%
Reinfection	1,188,135	(5.34%)
2nd infection		*5.04%
3rd + infection		*0.30% (5.34% of 1,188,135)
Total	22,241,810	100%

*****Assumed breakdowns.

Supplementary Table 4. Vaccine dose & timing and effectiveness against hospitalisation and ICU admission or death in infected

Vaccine dose and timing	Assumed proportions of Australian population[4]	Vaccine effectiveness against	
		Hospitalisation & ICU admission[5]	Death if infected
None	2%	0%	0%
1st			
3 weeks ago	2%	0%	0%
2nd			
2 weeks – 5 months ago	2%	71.24%	63.06% [12]
6–11 months ago	21%	54.4%	47.9% [12]
12+ months ago	21%	35.5%	49.7% [12]
3rd			
2 weeks – 5 months ago	2%	69.5%	79.44% [5]
6–11 months ago	21%	52.35%	62.38% [5]
12+ months ago	21%	52.3%	56.9% [5]
4th			
2–4 weeks ago	2%	83.53%	80.9% [5]
5–9 weeks ago	2%	78.95%	79.5% [5]
10–14 weeks ago	2%	71.48%	71.2% [5]
15+ weeks ago	2%	63.7%	68.2% [5]

Supplementary Table 5. Drug treatment

Drug treatment	Relative risk of		
	PASC	**Hospitalisation or ICU admission**	**Death**
None	1.0	1.0	1.0
Molnupiravir[8]	0.86	0.86	0.62
Metformin within 7 days of onset	0.59 [9]	0.42 [9]	0.47 [16]
Metformin within 3 days of onset	0.37 [9]	0.42 [9]	0.47 [16]
Nirmatrelvir[10]	0.74	0.76	0.53

Supplementary Table 6. Hospitalisations, ICU admissions and deaths from COVID-19 in the unvaccinated population of NSW during the omicron wave, 26/11/21–05/02/22[6]

Age group	Cases	Hospitalisations (proportion of cases)	ICU admissions (proportion of cases)	Deaths (proportion of cases)
18-60	77,433	451 (0.58%)	48 (0.06%)	13 (0.02%)
61-70	6693	146 (2.17%)	25 (0.37%)	21 (0.31%)
71+	4726	397 (8.40%)	38 (0.81%)	165 (3.49%

Supplementary Table 7. Long COVID outcome example calculation

Effect	Example: Six-month risk of cardiovascular long COVID for an unvaccinated female aged 65 years living with 4+ comorbidities who is hospitalised while experiencing COVID-19 for the second time, and received metformin within 7 days of symptom onset	Risk
Vaccination status[14]	Of 1000 symptomatic COVID-19 cases in unvaccinated persons, 102.52 are estimated to suffer from cardiovascular symptoms of long COVID six months post-infection. Risk = 0.10252	102.52 / 1000 = 0.1025
Infection number[7]	Those experiencing their second symptomatic SARS-CoV-2 infection have a hazard ratio of 2.1 for experiencing cardiovascular symptoms of long COVID six months post-infection. Risk = 0.10252*2.1	0.1025 * 2.1 = 0.2153
Hospitalisation or ICU status and Age[15]	Of 1000 hospitalised COVID-19 cases, 98.31 are estimated to suffer from cardiovascular symptoms of long COVID six months post-infection. This increases to 102.85 in those aged 61-70. The hazard ratio for this age range therefore equals 1.046 in comparison to the hazard ratio of 1 for the total hospitalised population.	0.2153 * 1.046 = 0.2252
Sex[15]	For hospitalised females, the six-month hazard ratio for suffering from cardiovascular symptoms of long COVID equals 0.904.	0.2252 * 0.904 = 0.2036
Number of comorbidities[15]	For hospitalised patients with four or more comorbidities, the six-month hazard ratio for suffering from cardiovascular symptoms of long COVID equals 1.391.	0.2036 * 1.391 = 0.2832
Drug treatment[9]	As this patient is high-risk due to living with multiple comorbidities, she is treated with metformin within seven days of symptom onset, reducing her relative risk to 0.59.	0.2832 * 0.59 = 0.1671

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