

Appendix to: The potential epidemiologic, clinical, and economic value of a universal coronavirus vaccine: a modelling study

Model Validation

Previous publications have described how validation of the model has proceeded.¹⁻³ For criterion validation, this model has been able to reproduce trends in infection rate, symptomatic cases, hospitalisations, and death rates seen through different phases of the COVID-19 pandemic. For example, when using R_0 2.5 (R_0 corresponding to the original Wuhan strain of SARS-CoV-2) and the probabilities of clinical outcomes observed in the beginning phases of the pandemic, the model generated 100,073,580 infections, 6,739,440 hospitalisations, and 787,375 deaths which aligns with the CDC reported 35,502,419 total infections, 2,420,372 total hospitalisations, and 589,172 deaths, when adjusting for various issues with Centers for Disease Control and Prevention (CDC) data, including data gaps around hospitalisations and deaths (e.g., missing values, unknown data points) and applying the CDC's factors for under-reporting.⁴

Appendix Table 1. Key model input parameters, values, and sources

Parameter	Distribution Type	Mean or Median	Standard Error or Range	Source
Coronavirus Transmission				
Latent period (days)	Triangular	5.2	4.1-7.0	5
Infectious period (days)	Uniform	-	3-14	6-9
Costs (2023 US\$)				
Annual wages (all occupations)	Beta Pert	48,546.78	25,440.38-72,767.13 ^a	10
Vaccination (base case)		60	-	11,12
Ambulatory care visit	Uniform	133.66	94.81-188.56	13
Telephone consult	Point Estimate	14.97	-	14
Over the counter medications, daily				
0-12 years old ^b	Gamma	0.11	0.11	15
≥13 years old ^c	Gamma	0.11	0.42	15
Hospitalisation for pneumonia ^d				
0-17 years old	Gamma	28,563.21	36939.59	16
18-44 years old	Gamma	13,227.01	19,580.06	16
45-64 years old	Gamma	16,247.94	20,274.48	16
65-84 years old	Gamma	15,645.24	17,322.53	16
≥85 years old	Gamma	14,717.23	20,614.44	16
Hospitalisation for severe non-pneumonia (all ages) ^e	Gamma	7,525.09	1,292.69	16
Hospitalisation for sepsis ^f				
0-17 years old ^g	Gamma	14,593.29	14,046.36	16
18-44 years old	Gamma	12,289.90	6,582.99	16
45-64 years old	Gamma	23,432.92	23,126.54	16
65-84 years old	Gamma	13,647.72	11,106.37	16
≥85 years old	Gamma	14,593.29	14,046.36	16
Hospitalisation for ARDS ^h				
0-17 years old	Gamma	192,956.48	309,183.65	16
18-44 years old	Gamma	98,658.64	112,090.40	16
45-64 years old	Gamma	90,091.19	134,818.54	16

65-84 years old	Gamma	58,817.21	79,956.93	16
≥85 years old	Gamma	48,358.10	45,918.10	16
Probabilities				
Asymptomatic infection	Triangular	0.35	0.315 - 0.385 ⁱ	17
Seroconversion (develop immunity after infection)	Beta Pert	0.760	0.6858-0.8382 ⁱ	18
Missing work/school	Point Estimate	1.0	-	Assumption
Ambulatory care	Triangular	0.15	0.06-0.26	19
Telephone Consult	-	1-probability of ambulatory care	-	Assumption
Hospitalisation, given infection				
0-17 years old	Beta Pert	0.031	0.028-0.034 ⁱ	20
18-44 years old	Beta Pert	0.056	0.051-0.062 ⁱ	20
45-64 years old	Beta Pert	0.140	0.126-0.154 ⁱ	20
≥65 years old	Beta Pert	0.300	0.270-0.330 ⁱ	20
ICU admission, given hospitalisation				
0-17 years old	Beta Pert	0.171	0.154-0.1881 ⁱ	20
18-44 years old	Beta Pert	0.152	0.137-0.1675 ⁱ	20
45-64 years old	Beta Pert	0.186	0.168-0.2047 ⁱ	20
≥65 years old	Beta Pert	0.148	0.133-0.163 ⁱ	20
Mortality, given hospitalisation				
0-17 years old	Uniform	-	0.0054-0.0215 ^j	20
18-44 years old	Uniform	-	0.0186-0.0745 ^j	20
45-64 years old	Uniform	-	0.0519-0.2076 ^j	20
≥65 years old	Uniform	-	0.1517-0.6068 ^j	20
Pneumonia, given hospitalisation	Beta	0.511	0.4599-0.5621	21
Sepsis, given hospitalisation				
18-44 years old	Beta	0.166	0.1494-0.1826	21,22
≥45 years old	Beta	0.249	0.2241-0.2739	21,23
ARDS, given hospitalisation				
18-44 years old	Beta	0.051	0.0459-0.0561	21,22
≥45 years old	Beta	0.169	0.1521-0.1859	21,22
Acute renal failure/acute kidney injury, given hospitalisation				
18-44 years old	Beta	0.061	0.0549-0.0671	21,22
≥45 years old	Beta	0.284	0.2556-0.3124	21,22
Acute respiratory failure, given hospitalisation				
18-44 years old	Beta	0.374	0.3366-0.4114	21,22
≥45 years old	Beta	0.529	0.4761-0.5819	21,22
Durations (days)				
Ambulatory care	Point Estimate	0.5	-	Assumption
Duration of symptoms with mild illness	Triangular	7	3-17	8,24,25
Duration of symptoms prior to hospital admission	Triangular	7	3-9 ⁱ	26,27
Hospitalisation, not admitted to ICU				
0-49 years old	Gamma	3.9	3.7	17
50-64 years old	Gamma	4.9	4.3	17
≥65 years old	Gamma	6.2	5.7	17
Hospitalisation, ICU (all ages)	Gamma	9	4-17 ^k	28-31
Hospitalisation, ventilator use	Gamma	9	5-12 ^k	28,30,32

Disability weights			
Mild/moderate illness	0.051	(0.032-0.074)	33
Severe illness	0.133	(0.088-0.190)	33
Critical illness (ICU admission)	0.655	(0.579-0.7127)	34

^aValues are 95% confidence interval

^bAssumes 5 to 10 mg/kg of ibuprofen orally every 6 to 8 hours as needed OR 10 to 15 mg/kg of acetaminophen orally every 4 to 6 hours as needed

^cAssumes 200 mg of ibuprofen or acetaminophen orally every 4 to 6 hours as needed

^dUses International Classification of Diseases, Tenth Revision, Clinical Modification (ICD10) code #J13 Pneumonia due to *Streptococcus pneumoniae*

^eUses International Classification of Diseases, Tenth Revision, Clinical Modification (ICD10) code #J11.89 Influenza due to unidentified influenza virus with other manifestations

^fUses International Classification of Diseases, Tenth Revision, Clinical Modification (ICD10) code #R65.21 Severe sepsis with septic shock

^gData for age-group unavailable and uses lowest values of all age-groups as a proxy

^hUses International Classification of Diseases, Tenth Revision, Clinical Modification (ICD10) code #J96.22 Acute and chronic respiratory failure with hypercapnia for 18 years and older and ICD10 code #J96.20 Acute and chronic respiratory failure, unspecified whether with hypoxia or hypercapnia for 0 to 17-year olds

ⁱValues are a relative +/- 10% of the mean or median value

^jValues are interquartile range

^kValues are 10%-90%

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