

Economic analysis of an additional dose of the 2024-2025 COVID-19 vaccine

University of Michigan
COVID-19 Vaccination Modeling Team

Presentation to the Advisory Committee on Immunization Practices



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Conflict of interest statement

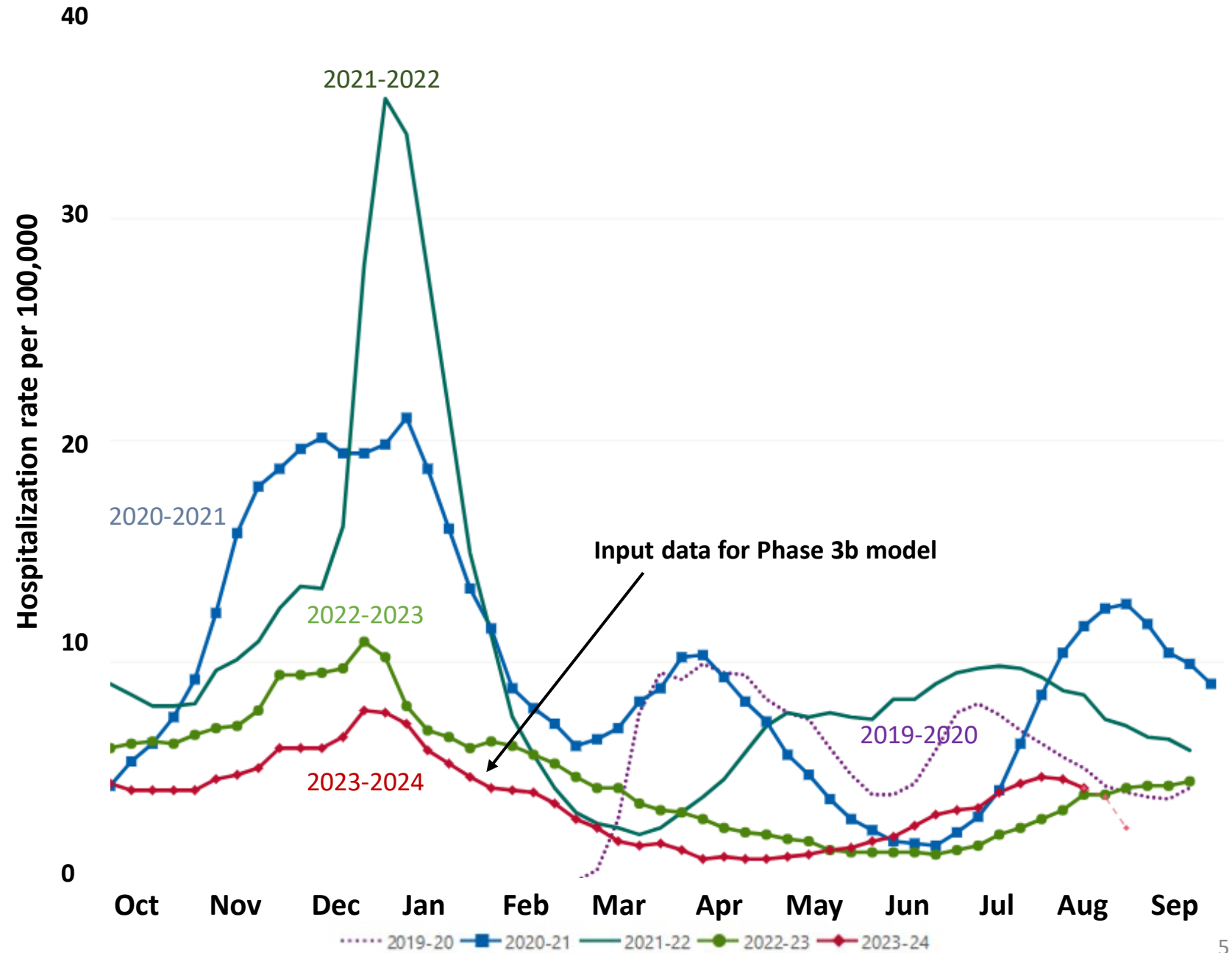
Authors have no known conflicts of interest.

Objectives

- Original aims*:
 - Estimate annual disease burden and healthcare utilization associated with COVID-19 illness and COVID-19 booster vaccination, including cases of symptomatic illness, hospitalizations, deaths, adverse events, costs, and quality-adjusted life years
 - Project cost-effectiveness of an updated mRNA booster against COVID-19-associated illness in persons ages ≥ 18 years
- Updates to the current version of the model (Phase 3B):
 - 2-dose strategy (an additional mid-year dose)
 - 2023-2024 hospitalization rates (COVID-NET data)
 - Vaccine dose costs reflect CDC-negotiated 2024-2025 prices
 - All cost inputs adjusted to 2024\$

* Earlier analyses from this model were presented to ACIP in September 2023, February 2024, and June 2024: Prosser, Lisa A. (2023). Economic Analysis of Vaccination with mRNA Booster Dose against COVID-19 Among Adults; Prosser, Lisa A (2024). Economic analysis of an additional dose of COVID-19 vaccine; Prosser, Lisa A (2024). Economic Analysis of COVID-19 Vaccination.

Weekly rates of COVID-19 associated hospitalizations by season, all ages



Source: COVID-NET

Probability of hospitalization due to COVID-19 illness

Age groups	2023-2024	2022-2023	% change
5-11 years	0.000105	0.000133	-21%
12-17 years	0.000139	0.000181	-23%
18-49 years	0.000299	0.000443	-33%
50-64 years	0.001184	0.001551	-24%
≥65 years	0.006778	0.007901	-14%

Updated seasonality-adjusted vaccine impact*

Health outcomes	Age	Seasonality-adjusted vaccine impact					
		1-dose strategy			2-dose strategy		
		Base case	Low	High	Base case	Low	High
<ul style="list-style-type: none"> Symptomatic illness (non-hospitalized) Hospitalization, uncomplicated 	5-11 y	0.375	0.112	0.705	0.512	0.158	0.716
	12-17 y	0.379	0.110	0.704	0.501	0.143	0.711
	18-49 y	0.295	0.106	0.442	0.404	0.144	0.482
	50-64 y	0.310	0.118	0.453	0.416	0.157	0.492
	≥65 y	0.315	0.121	0.455	0.422	0.163	0.498
<ul style="list-style-type: none"> Critical illness** Death 	5-11 y	0.375	0.112	0.705	0.512	0.158	0.716
	12-17 y	0.379	0.110	0.704	0.501	0.143	0.711
	18-49 y	0.391	0.221	0.662	0.527	0.355	0.666
	50-64 y	0.402	0.234	0.665	0.534	0.366	0.670
	≥65 y	0.410	0.238	0.665	0.536	0.369	0.671

* Updated hospitalization rates Oct 23- Sept 24

**Hospitalization requiring ICU and/or ventilator assistance

Source: COVID-NET, VISION, and IVY

Seasonality-adjusted vaccine impact, 2023-2024 v. 2024-2025

Age group	1-dose	2-dose
Seasonality-adjusted vaccine impact against symptomatic illness or hospitalization		
5-11 years	-11%	-1%
12-17 years	-10%	-6%
18-49 years	-18%	-6%
50-64 years	-13%	-5%
65+ years	-9%	-3%
Seasonality-adjusted vaccine impact against critical care (hospitalization with ICU stay or death)		
5-11 years	-11%	-1%
12-17 years	-10%	-6%
18-49 years	-15%	-3%
50-64 years	-12%	-3%
65+ years	-9%	-2%

Vaccine dose cost, 2023-2024 v. 2024-2025

	2023				2024				% change
	CDC	Private sector	% VFC or Bridge	Base case	CDC	Private sector	% VFC or Bridge	Base case	
5-11 y									
Pfizer	\$65.45	\$77.00	50%	\$89.09	\$65.45	\$77.00	54%	\$88.25	-1%
Moderna	\$85.91	\$128.00			\$85.91	\$129.00			
12-17 y									
Pfizer	\$97.75	\$115.00	50%	\$102.44	\$99.71	\$136.75	54%	\$114.18	10%
Moderna	\$85.91	\$128.00			\$85.91	\$141.80			
18+ y									
Pfizer	\$97.75	\$115.00	12.8%	\$118.73	\$99.71	\$136.75	NA	\$139.28	15%
Moderna	\$85.91	\$128.00			\$85.91	\$141.80			

Additional assumptions: 2-dose strategy

- Adverse events: Twice the number of the 1-dose strategy
- Costs of vaccination: Twice the cost of the 1-dose strategy
- See additional slides

Analysis Plan

- Conduct base case and uncertainty analyses (one-way sensitivity and scenario analyses) comparing no vaccination, 1-dose, and 2-dose strategies
- Project disaggregated outcomes stratified by intervention strategy and by age subgroups (5-11y, 12-17y, 18-49y, 50-64y, $\geq 65y$) – supplemental slides
 - Cases
 - Hospitalizations
 - ICU
 - Long COVID
 - Deaths
 - Costs
 - QALYs
 - Adverse events

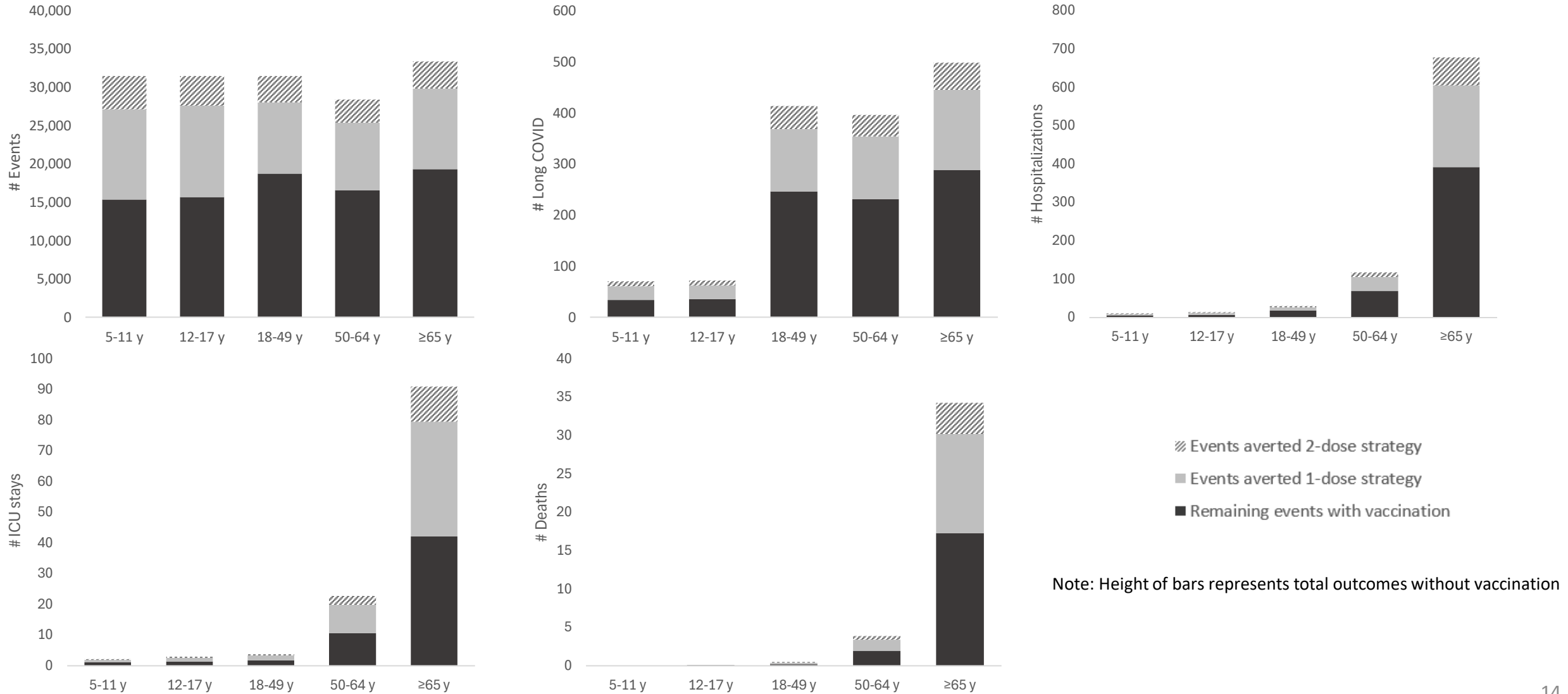
****This presentation reports preliminary results from the fourth phase of an ongoing analysis****

Analysis Plan cont.: Uncertainty analyses

- Multi-way sensitivity analyses/parameter sets
 - Vaccination-related costs
 - Vaccination settings
 - Hospitalization and critical illness
- Scenario analyses
 - Seasonality adjusted vaccine impact
 - Alternative seasonality scenarios
 - Probability of hospitalization- proxy for lower and higher risk cohorts
 - Probability of critical care- proxy for higher risk cohorts
 - Probability of symptomatic illness
 - Vaccine dose cost
- One-way sensitivity analyses

Results

Disaggregated results, per 100,000, societal perspective, 2024-2025 vaccination, *preliminary results*



Disaggregated results, per 100,000, societal perspective, 2024-2025 vaccination, *preliminary results*

Age	Intervention strategy	Outcomes					Outcomes Averted				
		Cases	Long COVID	Hosp.	ICU	Deaths	Cases	Long COVID	Hosp.	ICU	Deaths
5-11 y	No vaccination	31,450	70.6	10.5	2.2	0.1	-	-	-	-	-
	Vaccination, 1-dose	19,656	44.1	6.6	1.3	0.1	11,794	26.5	3.9	0.8	0.0
	Vaccination, 2-dose	15,348	34.4	5.1	1.1	0.0	4,309	9.7	1.4	0.3	0.0
12-17 y	No vaccination	31,450	71.5	13.9	2.9	0.1	-	-	-	-	-
	Vaccination, 1-dose	19,530	44.4	8.6	1.8	0.1	11,919	27.1	5.3	1.1	0.0
	Vaccination, 2-dose	15,694	35.7	6.9	1.4	0.1	3,837	8.7	1.7	0.4	0.0
18-49 y	No vaccination	31,450	413.0	29.9	3.9	0.4	-	-	-	-	-
	Vaccination, 1-dose	22,172	299.1	21.1	2.4	0.2	9,278	121.8	8.8	1.5	0.2
	Vaccination, 2-dose	18,744	246.1	17.8	1.8	0.2	3,428	45.0	3.3	0.5	0.1
50-64 y	No vaccination	28,410	395.4	118.0	22.8	3.8	-	-	-	-	-
	Vaccination, 1-dose	19,603	272.8	81.4	13.6	2.3	8,807	122.6	36.6	9.2	1.5
	Vaccination, 2-dose	16,591	230.9	68.9	10.6	1.9	3,011	41.9	12.5	3.0	0.5
≥65 y	No vaccination	33,390	498.2	678.0	90.9	34.4	-	-	-	-	-
	Vaccination, 1-dose	22,872	341.3	464.4	53.6	21.4	10,518	156.9	213.6	37.3	12.9
	Vaccination, 2-dose	19,299	288.0	391.9	42.2	17.3	3,573	53.3	72.6	11.5	4.1

Incremental cost-effectiveness ratios (ICERs), per 1000, societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	Projected costs	Incremental costs	Projected QALYs	Incremental QALYs	ICER (\$/QALY)
5-11 y	No vaccination	\$39,723	-	26,788	-	-
	Vaccination, 1-dose	\$191,776	\$152,053	26,789	0.6566	\$231,570
	Vaccination, 2-dose	\$353,283	\$161,507	26,789	0.2129	\$758,268
12-17 y	No vaccination	\$46,010	-	24,638	-	-
	Vaccination, 1-dose	\$214,115	\$168,105	24,639	0.6733	\$249,670
	Vaccination, 2-dose	\$394,045	\$179,930	24,639	0.1942	\$926,390
18-49 y	No vaccination	\$128,351	-	20,208	-	-
	Vaccination, 1-dose	\$289,206	\$160,855	20,209	0.4802	\$335,010
	Vaccination, 2-dose	\$474,497	\$185,290	20,209	0.1633	\$1,134,840
50-64 y	No vaccination	\$218,703	-	12,278	-	-
	Vaccination, 1-dose	\$347,499	\$128,796	12,279	0.6197	\$207,834
	Vaccination, 2-dose	\$523,448	\$175,949	12,279	0.1957	\$898,653
≥65 y	No vaccination	\$336,230	-	6,525	-	-
	Vaccination, 1-dose	\$419,404	\$83,174	6,527	1.4132	\$58,855
	Vaccination, 2-dose	\$577,132	\$157,729	6,528	0.4424	\$356,534

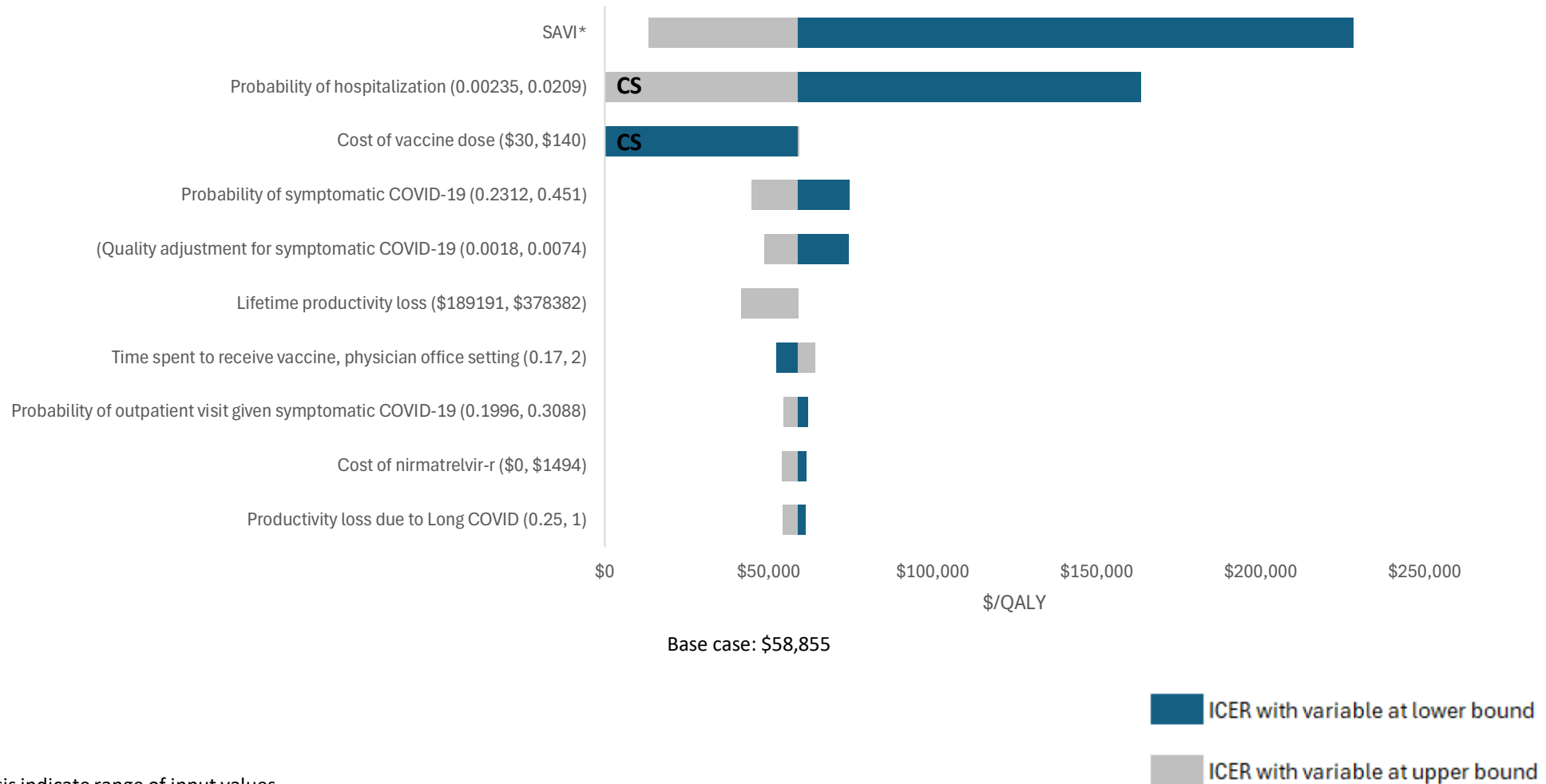
ICER = incremental cost effectiveness ratio; QALY = quality-adjusted life year

Incremental cost-effectiveness ratios (ICERs), adding a 2-dose strategy, societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	ICER (\$/QALY)
5-11 y	No vaccination	-
	Vaccination, 1-dose	\$231,570
	Vaccination, 2-dose	\$758,268
12-17 y	No vaccination	-
	Vaccination, 1-dose	\$249,670
	Vaccination, 2-dose	\$926,390
18-49 y	No vaccination	-
	Vaccination, 1-dose	\$335,010
	Vaccination, 2-dose	\$1,134,840
50-64y	No vaccination	-
	Vaccination, 1-dose	\$207,834
	Vaccination, 2-dose	\$898,653
≥65 y	No vaccination	-
	Vaccination, 1-dose	\$58,855
	Vaccination, 2-dose	\$356,534

QALY = quality-adjusted life year

1-way sensitivity analyses, 1-dose strategy, ≥ 65 y

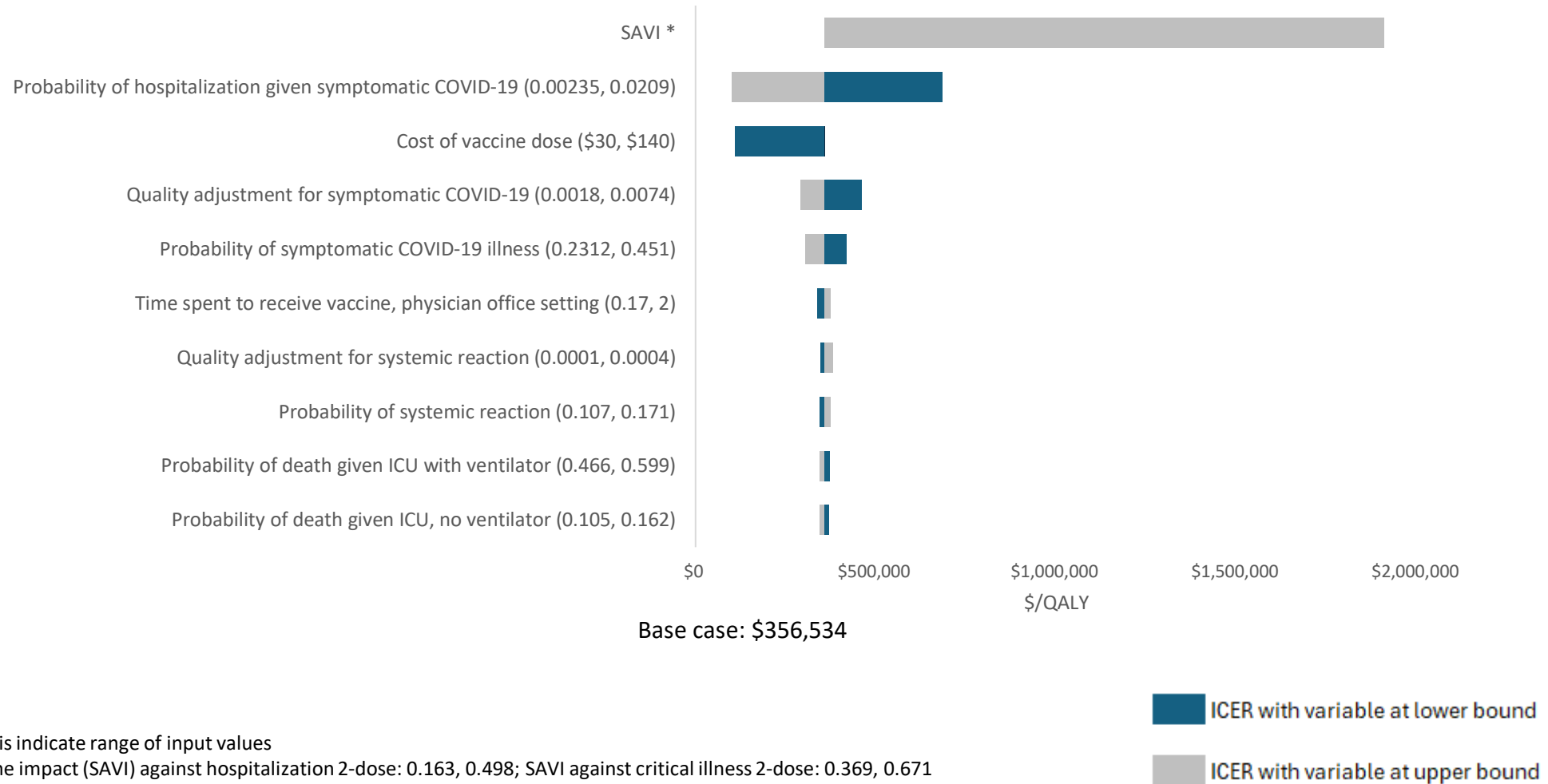


Note: Numbers in parenthesis indicate range of input values

* Seasonality adjusted vaccine impact (SAVI) against hospitalization 1-dose: 0.121, 0.455; SAVI against critical illness 1-dose: 0.238, 0.665

QALY = quality-adjusted life year; ICER = incremental cost effectiveness ratio; SAVI = seasonality-adjusted vaccine impact; CS = cost-saving

1-way sensitivity analyses, 2-dose strategy, ≥ 65 y



Note: Numbers in parenthesis indicate range of input values

* Seasonality adjusted vaccine impact (SAVI) against hospitalization 2-dose: 0.163, 0.498; SAVI against critical illness 2-dose: 0.369, 0.671

QALY = quality-adjusted life year; ICER = incremental cost effectiveness ratio; SAVI = seasonality-adjusted vaccine impact

ICERs, 1-way sensitivity analysis, probability of hospitalization, societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	ICER (\$/QALY)		
		Base case	Lower bound	Upper bound
5-11 y	Vaccination, 1-dose	\$231,570	\$237,799	\$216,062
	Vaccination, 2-dose	\$758,268	\$773,808	\$719,816
12-17 y	Vaccination, 1-dose	\$249,670	\$256,907	\$230,464
	Vaccination, 2-dose	\$926,390	\$944,391	\$878,879
18-49 y	Vaccination, 1-dose	\$335,010	\$363,084	\$183,058
	Vaccination, 2-dose	\$1,134,840	\$1,207,451	\$746,171
50-64 y	Vaccination, 1-dose	\$207,834	\$309,213	\$29,782
	Vaccination, 2-dose	\$898,653	\$1,208,636	\$373,246
≥65 y	Vaccination, 1-dose	\$58,855	\$163,421	Cost saving
	Vaccination, 2-dose	\$356,534	\$682,429	\$99,455

*Probability of hospitalization inputs, base case (range): 5-11 y: 0.000105 (0.0000168 - 0.000336); 12- 17 y: 0.000139 (0.0000252 - 0.000456); 18-49 y: 0.000299 (0.0000799 - 0.00204); 50-64 y: 0.00118 (0.000348 - 0.00479); ≥65 y 0.00678 (0.00235 - 0.02090)

ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year

ICER, scenario analysis varying probability of hospitalization, societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	ICER (\$/QALY)					
		¼ base case	½ base case	Base case	2x base case	3x base case	4x base case
5-11 y	Vaccination, 1-dose	\$237,123	\$235,256	\$231,570	\$224,381	\$217,426	\$210,693
	Vaccination, 2-dose	\$772,119	\$767,458	\$758,268	\$740,400	\$723,184	\$706,585
12-17 y	Vaccination, 1-dose	\$256,292	\$254,067	\$249,670	\$241,081	\$232,755	\$224,680
	Vaccination, 2-dose	\$942,860	\$937,321	\$926,390	\$905,095	\$884,525	\$864,645
18-49 y	Vaccination, 1-dose	\$363,779	\$353,853	\$335,010	\$300,917	\$270,898	\$244,263
	Vaccination, 2-dose	\$1,209,252	\$1,183,547	\$1,134,840	\$1,046,999	\$969,960	\$901,847
50-64 y	Vaccination, 1-dose	\$317,597	\$274,393	\$207,834	\$121,533	\$68,015	\$31,582
	Vaccination, 2-dose	\$1,234,636	\$1,101,255	\$898,653	\$641,036	\$484,085	\$378,439
≥65 y	Vaccination, 1-dose	\$192,897	\$127,480	\$58,855	\$1,483	Cost saving	Cost saving
	Vaccination, 2-dose	\$775,607	\$569,600	\$356,534	\$180,751	\$103,912	\$60,824

Adjusted risk of hospitalization by underlying condition: hypertension: 2.8, coronary artery disease: 1.3, history of stroke: 0.9, diabetes: 3.2, obesity: 2.9, severe obesity: 4.4, chronic kidney disease: 4.0, asthma: 1.4, chronic obstructive pulmonary disease: 0.9 . Ko et al 2021.

ICER = incremental cost effectiveness ratio; QALY = quality-adjusted life year

ICER, scenario analysis varying probability of hospitalization*, age ≥ 65 , societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	ICER (\$/QALY)					
		¼ base case (169 per 100,000)	½ base case (339 per 100,000)	Base case (678 per 100,000)	2x base case (1356 per 100,000)	3x base case (2033 per 100,000)	4x base case (2711 per 100,000)
≥ 65 y	Vaccination, 1-dose	\$192,897	\$127,480	\$58,855	\$1,483	Cost saving	Cost saving
	Vaccination, 2-dose	\$775,607	\$569,600	\$356,534	\$180,751	\$103,912	\$60,824

*Adjusted risk of hospitalization by underlying condition: chronic obstructive pulmonary disease: 0.9, history of stroke: 0.9, coronary artery disease: 1.3, asthma: 1.4, hypertension: 2.8, obesity: 2.9, diabetes: 3.2, chronic kidney disease: 4.0, severe obesity: 4.4. Ko et al 2021.
 ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year

ICER, scenario analysis varying probability of critical care, societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	ICER (\$/QALY)			
		Base case*	2x	3x	4x
5-11 y	Vaccination, 1-dose	\$231,570	\$226,638	\$221,839	\$217,169
	Vaccination, 2-dose	\$758,268	\$744,568	\$731,285	\$718,401
12-17 y	Vaccination, 1-dose	\$249,670	\$245,073	\$240,586	\$236,205
	Vaccination, 2-dose	\$926,390	\$912,162	\$898,312	\$884,826
18-49 y	Vaccination, 1-dose	\$335,010	\$310,742	\$288,947	\$269,266
	Vaccination, 2-dose	\$1,134,840	\$1,066,161	\$1,004,627	\$949,177
50-64 y	Vaccination, 1-dose	\$207,834	\$146,192	\$105,154	\$75,870
	Vaccination, 2-dose	\$898,653	\$692,143	\$556,444	\$460,466
≥65 y	Vaccination, 1-dose	\$58,855	\$28,898	\$12,731	\$2,614
	Vaccination, 2-dose	\$356,534	\$239,110	\$175,202	\$135,015

*Base case probability of ICU given hospitalization: 5-11 y- 0.205; 12-17 y- 0.208; 18-49 y- 0.130; 50-64 y- 0.193, ≥65 y- 0.134

Adjusted risk ratios for ICU: 1 condition: 1.32, 2-5 conditions: 1.60, 6-10 conditions: 1.84, >10 conditions: 1.96. Underlying conditions: Essential hypertension, Disorders of lipid metabolism, Obesity, Diabetes with complication, Coronary atherosclerosis and other heart disease, Esophageal disorders, Chronic kidney disease, Anxiety and fear-related disorders, COPD and bronchiectasis, Thyroid disorders, Depressive disorders, Implant device or graft-related encounter, Sleep-wake disorders, Neurocognitive disorders, Osteoarthritis, Aplastic anemia, Diabetes without complication, Asthma. Source: Kompaniyets et al 2021.

ICER = incremental cost effectiveness ratio; QALY = quality-adjusted life year

Scenario analysis: vaccination-related costs, societal perspective, 2024-2025 vaccination, *preliminary results*

Age group	Intervention strategy	ICER (\$/QALY)		
		Base case	All lower	All upper
5-11 y	Vaccination, 1-dose	\$231,570	\$103,396	\$353,999
	Vaccination, 2-dose	\$758,268	\$363,134	\$1,135,689
12-17 y	Vaccination, 1-dose	\$249,670	\$92,955	\$325,103
	Vaccination, 2-dose	\$926,390	\$383,118	\$1,187,889
18-49 y	Vaccination, 1-dose	\$335,010	\$71,945	\$382,665
	Vaccination, 2-dose	\$1,134,840	\$361,230	\$1,274,981
50-64 y	Vaccination, 1-dose	\$207,834	\$4,019	\$244,737
	Vaccination, 2-dose	\$898,653	\$253,551	\$1,015,457
≥65 y	Vaccination, 1-dose	\$58,855	Cost saving	\$75,585
	Vaccination, 2-dose	\$356,534	\$70,458	\$409,976

ICER = incremental cost effectiveness ratio; QALY = quality-adjusted life year

ICER, scenario analyses varying vaccination costs, age ≥ 65 , societal perspective, 2024-2025 vaccination, *preliminary results*

Varying all vaccination-related costs*

Age group	Intervention strategy	ICER (\$/QALY)		
		All lower	Base case	All upper
≥ 65 y	Vaccination, 1-dose	Cost saving	\$58,855	\$75,585
	Vaccination, 2-dose	\$70,458	\$356,534	\$409,976

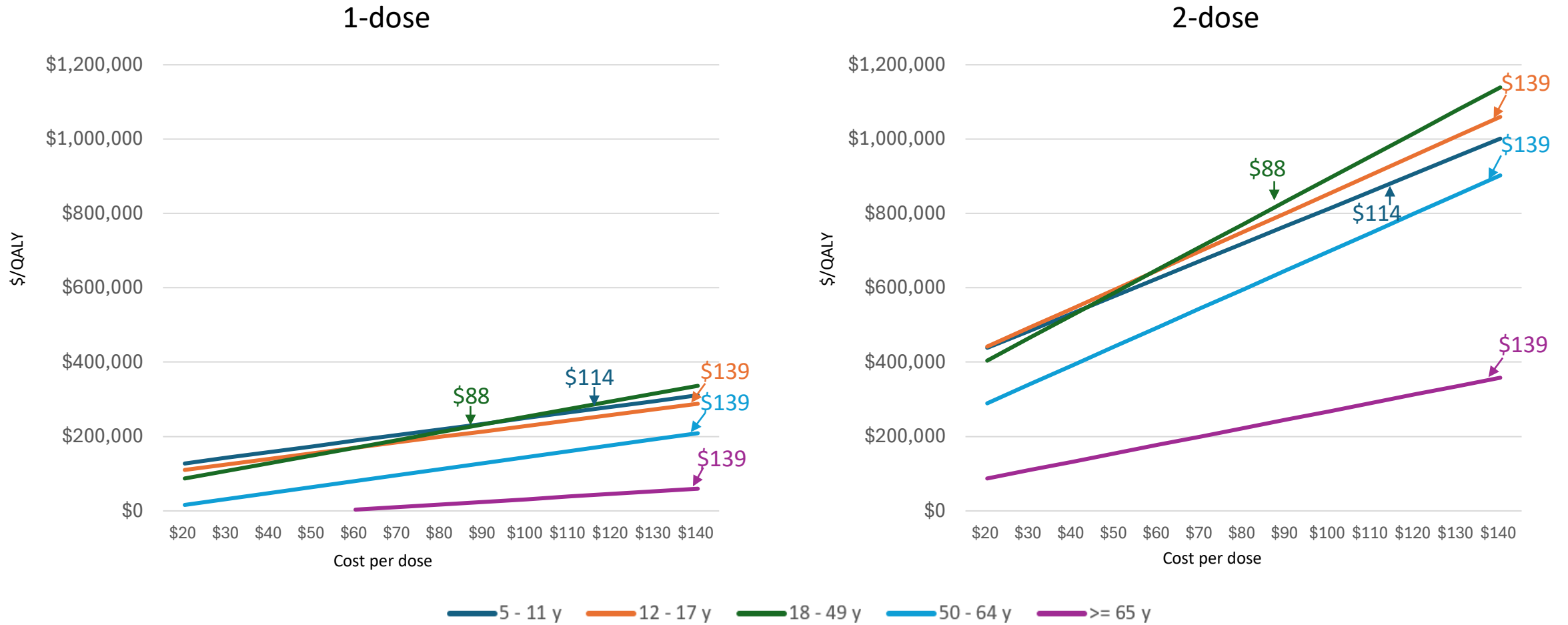
*Multi-way sensitivity analysis varying vaccine dose cost, vaccine administration cost, time costs of vaccination, and cost of vaccine-associated adverse events to lower and upper bounds. See supplementary slide 44 for input data.

Varying vaccine dose cost only

Age group	Intervention strategy	ICER (\$/QALY)				
		\$20	\$60	\$80	\$100	Base case \$133
≥ 65 y	Vaccination, 1-dose	Cost saving	\$2,755	\$16,908	\$31,060	\$58,855
	Vaccination, 2-dose	\$86,910	\$177,327	\$222,536	\$267,744	\$356,534

ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year

Scenario analysis: vaccine dose cost, 2024-2025 vaccination, *preliminary results*



Note: arrows indicate base case vaccine dose cost by age group
QALY= quality-adjusted life year

Limitations

- Unpublished data used to derive key parameters in the model: vaccine effectiveness, symptomatic illness, probabilities of hospitalization and critical illness
- Data sources vary in representativeness, generalizability
- VE estimates derived from single prior season data
- Few seasons to date to estimate seasonality
- MarketScan data for ages ≥ 65 only includes those with supplemental insurance
- Evidence base for long covid is especially scarce
- Model does not include reduced transmission (conservative approach)

Summary

2024-2025 COVID-19 vaccination, 2-dose strategy

- ICERs for age groups <65 y were less favorable than for those ≥ 65 y across plausible parameter ranges
- For ≥ 65 years, ICERs are sensitive to seasonality-adjusted vaccine impact, probability of hospitalization, and costs of vaccination
- ICERs are more favorable in scenarios with higher risk of hospitalization and lower costs of vaccination