Economic Analysis of COVID-19 Vaccination

University of Michigan

COVID-19 Vaccination Modeling Team

Presentation to the Advisory Committee on Immunization Practices

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SCHOOL OF PUBLIC HEALTH
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Study team

- **University of Michigan**
- **Wake Forest University**
- **Centers for Disease Control and Prevention**

Conflict of interest statement

No known conflicts of interest.

Economic Analysis of COVID-19 Vaccination: Objectives

Using an economic model of COVID-19 vaccination:

- Estimate the annual population burden of disease in a cohort representing the US population
  - resource utilization (outpatient visits, hospitalizations)
  - total cases
  - total costs
  - deaths
  - quality-adjusted life years lost due to COVID-19
- Estimate events averted by COVID-19 vaccination
- Estimate incremental cost-effectiveness ratios for subgroups defined by age and risk status

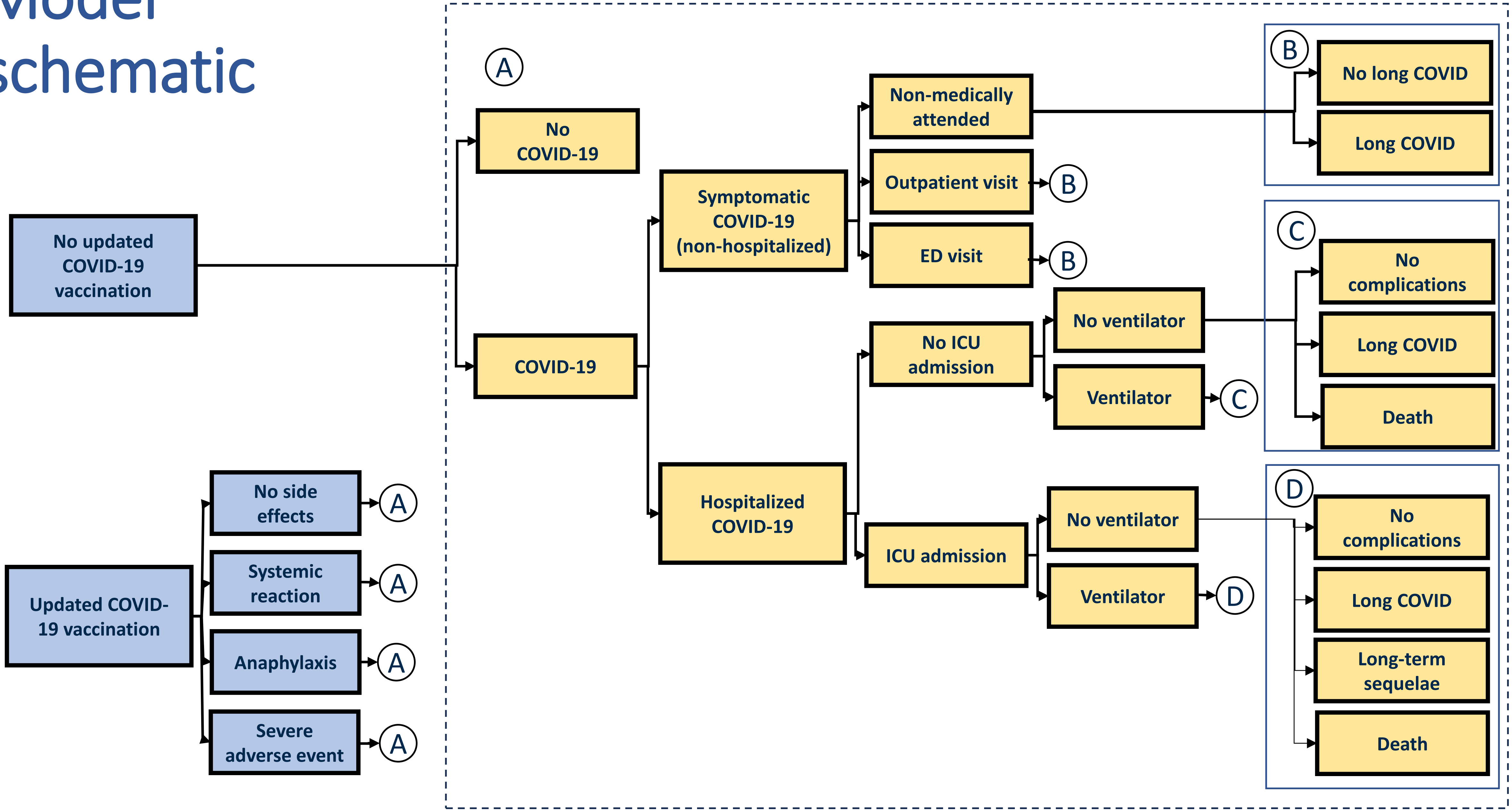
Earlier analyses from this model were presented to ACIP in September 2023, February 2024, June 2024, and October 2024: Prosser, Lisa A. (2023). Economic Analysis of Vaccination with mRNA Booster Dose against COVID-19 Among Adults; Prosser, Lisa A (2024). Economic analysis of an additional dose of COVID-19 vaccine; Prosser, Lisa A. (2024). Economic analysis of COVID-19 vaccination; Prosser, Lisa A. (2024). Economic analysis of an additional dose of the 2024-2025 COVID-19 vaccine.

Methods

- Intervention strategies:
  - Vaccination against COVID-19 illness with an updated “generic” mRNA booster
  - No updated mRNA booster (vaccination against COVID-19 illness with primary series only or primary series plus current booster)
- Target population: all US adults, stratified by age and risk status
  - 18-49 y, 50-64 y, ≥65 y
  - High risk or not at high risk for complications
  - Pediatric and adolescent age groups excluded from current analysis, insufficient data to incorporate into this first phase analysis
- Time horizon: 1 year*
- Perspective: Societal
- Costing year: 2024$
- Discount rate: 3%

*Costs and QALYs lost due to long-term sequelae and deaths beyond one year are included

Model schematic



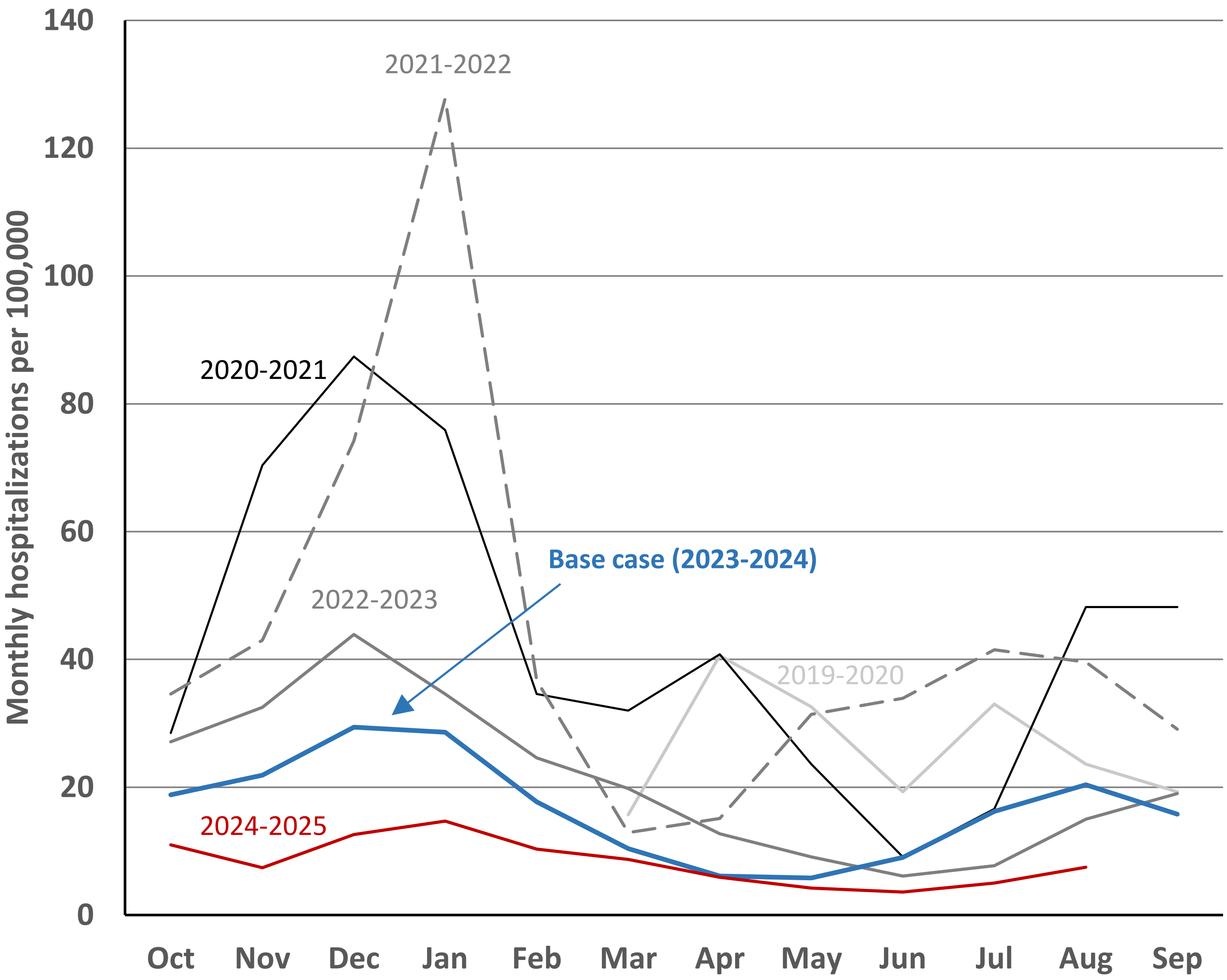
ED = emergency department; ICU = intensive care unit

Prosser et al. Cost-effectiveness of 2023-2024 COVID-19 vaccination in US adults. JAMA Network Open. 2025 Aug 1;8(8):e2523688.

Epidemiological inputs

Input	Source
Probability of symptomatic illness	HEROES-RECOVER (2022 – 2023)
Probability of medically attended illness	MarketScan (2022)
Probability of hospitalization	COVID-NET (2023 - 2024), expert opinion
Probability of ICU stay and ventilator use	COVID-NET (2022 – 2023)
Probability of death	COVID-NET (2022 – 2023)
Probability of long-term sequalae	Published literature
Probability of long COVID	Published literature

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



Source: COVID-NET

Vaccination-related parameter inputs

Input	Source
Seasonality-adjusted vaccine impact (SAVI)	VISION (2024 – 2025), IVY (2024 – 2025), COVID-NET (2023 – 2024), expert opinion
Probabilities of adverse events • Systemic reaction • Anaphylaxis • Myocarditis/pericarditis	FDA product approval information, published literature, expert opinion

Costs

Input	Source
Illness-related	
Direct medical costs • Outpatient visits • ED visits • Hospitalizations • Long-term sequalae • Long COVID	MarketScan 2022-2023, published literature
Productivity losses	BLS, published literature, expert opinion
Vaccination-related	
Direct medical costs: • Vaccine dose • Administration • Adverse events	CDC vaccine price list Physician fee schedule Published literature, expert opinion
Time costs of vaccination	Published literature

BLS = Bureau of Labor Statistics

Quality of life adjustments

Input	Source
Illness-related	
• Symptomatic illness • Hospitalization • Long-term sequalae • Long COVID	Published literature
Vaccination-related	
• Systemic reaction • Anaphylaxis • Myocarditis/pericarditis	Published literature

Methods: Analysis Plan

- Project health and economic outcomes stratified by intervention strategy, age (18-49 y, 50-64 y, ≥65 y) and risk subgroups (high risk, non-high risk)
  - Cases
  - Hospitalizations
  - Deaths
  - Costs
  - Quality-Adjusted Life-Years (QALYs)
  - Adverse events
  - Number needed to vaccinate (NNV)

Methods: Analysis Plan

- Incremental cost-effectiveness ratio (ICER):

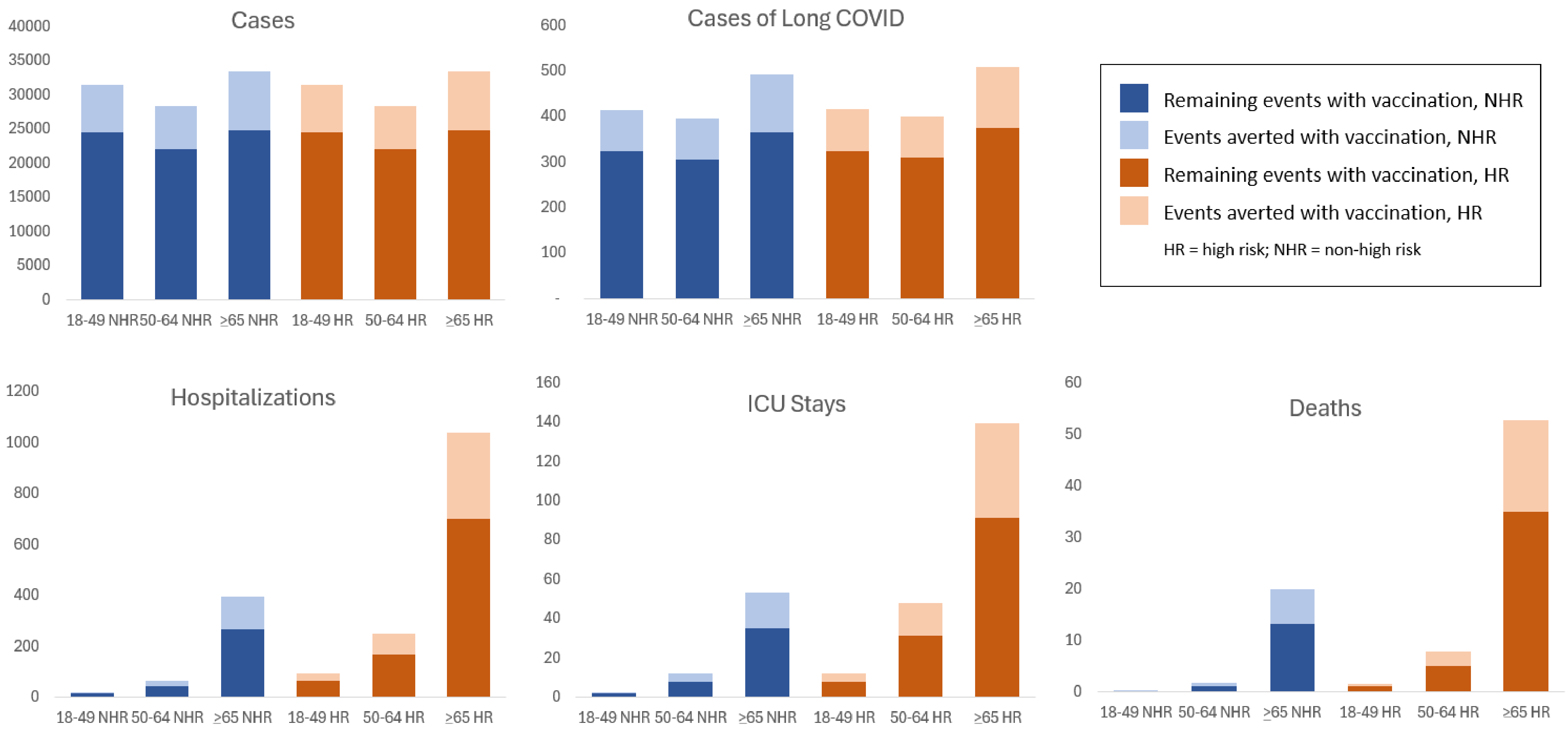
$$\frac{\text{Costs}_{\text{Updated Vaccination}} - \text{Costs}_{\text{No Updated Vaccination}}}{\text{QALYs}_{\text{Updated Vaccination}} - \text{QALYs}_{\text{No Updated Vaccination}}}$$

- Base case analysis
- Sensitivity analyses
  - Probabilistic sensitivity analysis
  - Univariate and multi-way sensitivity analyses
  - Scenario analyses

Results*

**This presentation reports preliminary results of an ongoing analysis*

Disaggregated results, per 100,000 simulated cohort, societal perspective, 2025-2026 vaccination



Incremental cost-effectiveness ratios (ICERs), 2025-2026 vaccination, per cohort of 1,000,000

Age	Strategy	Cost	Incremental cost	QALYs	Incremental QALYs	$/QALY
Non-high-risk						
18 - 49 y	No vaccination	$121,084,319	-	20,208,352	-	-
	Vaccination	$292,804,184	$171,719,865	20,208,697	345	$498,090
50 - 64 y	No vaccination	$172,993,823	-	12,278,283	-	-
	Vaccination	$329,875,771	$156,881,948	12,278,676	393	$398,809
≥65 y	No vaccination	$213,552,333	-	6,526,870	-	-
	Vaccination	$345,570,759	$132,018,426	6,527,758	887	$148,811
High-risk						
18 - 49 y	No vaccination	$166,726,302	-	20,208,138	-	-
	Vaccination	$323,381,110	$156,654,808	20,208,555	417	$375,399
50 - 64 y	No vaccination	$295,589,269	-	12,277,500	-	-
	Vaccination	$411,159,262	$115,569,993	12,278,163	663	$174,359
≥65 y	No vaccination	$395,948,683	-	6,524,593	-	-
	Vaccination	$467,984,279	$72,035,596	6,526,248	1655	$43,537

QALY = quality-adjusted life year

Base-case and probabilistic sensitivity analyses, 2025-2026 vaccination

Age	ICER ($/QALY)	
	Base case	95% confidence interval
Non-high-risk		
18 - 49 y	$498,090	$309,220 - $913,905
50 - 64 y	$398,809	$252,690 - $691,360
≥65 y	$148,811	$78,132 - $276,981
High-risk		
18 - 49 y	$375,399	$232,241 - $659,757
50 - 64 y	$174,359	$66,920 - $388,115
≥65 y	$43,537	Cost-saving - $142,478

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

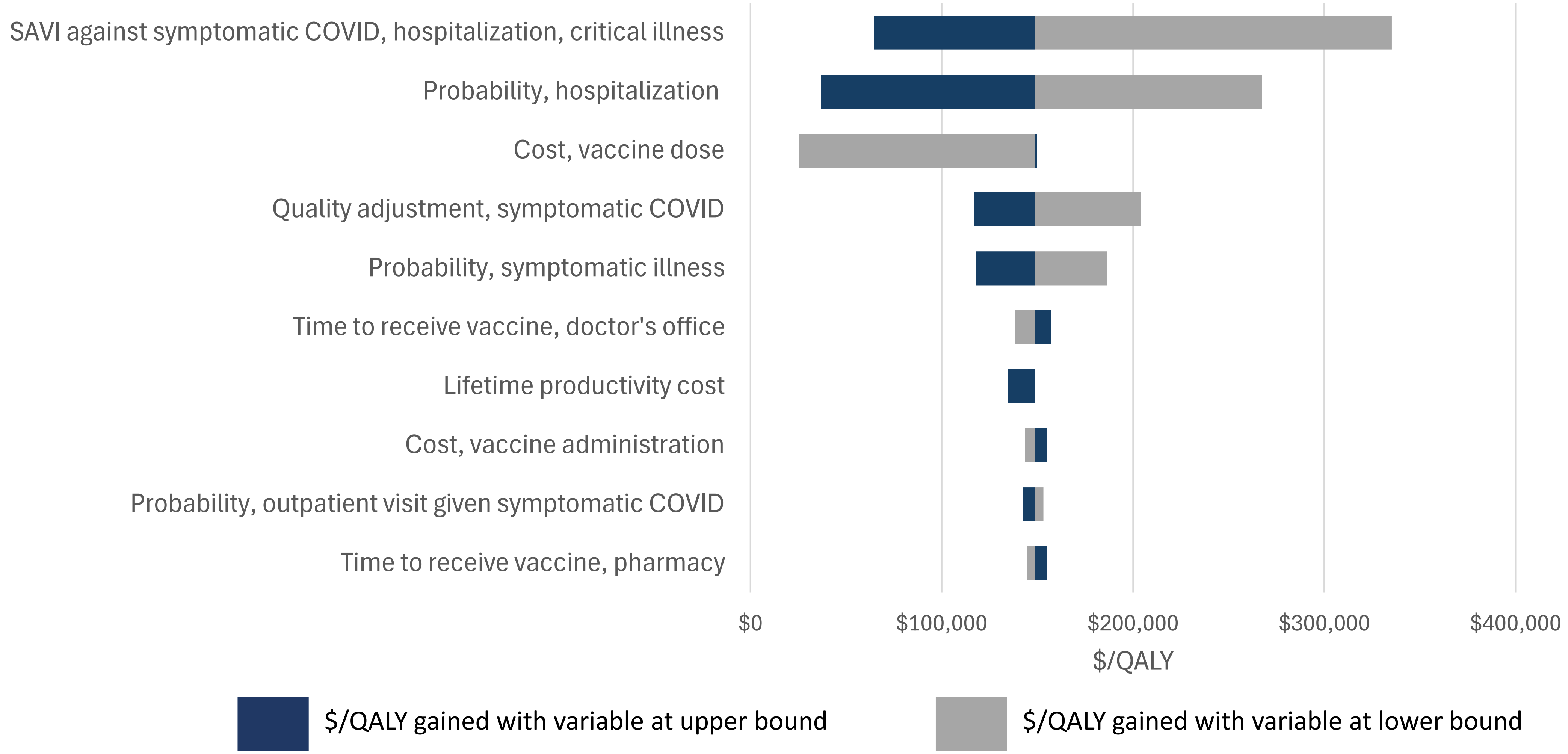
Number needed to vaccinate (NNV), 2025-2026 vaccination, base case

Age	NNV to avert a case	NNV to avert a hospitalization	NNV to avert a death
Non-high-risk			
18 - 49 y	15	15,746	1,133,330
50 - 64 y	16	4,897	145,755
≥65 y	12	778	14,818
High-risk			
18 - 49 y	15	3,351	241,229
50 - 64 y	16	1,227	36,522
≥65 y	12	296	5,642

Cost/outcome averted, 2025-2026 vaccination, base case

Age	$/Case averted	$/Hospitalization averted	$/Death averted
Non-high-risk			
18 - 49 y	$2,504	$2,703,838	$194,615,325
50 - 64 y	$2,474	$768,180	$22,866,393
≥65 y	$1,540	$102,729	$1,956,219
High-risk			
18 - 49 y	$2,282	$525,021	$37,789,676
50 - 64 y	$1,817	$141,797	$4,220,853
≥65 y	$836	$21,344	$406,450

One-way sensitivity analysis, ≥65 years, non-high-risk



Base case: $148,811/QALY
SAVI = seasonality-adjusted vaccine impact

One-way sensitivity analysis: probability of hospitalization

Age	ICER ($/QALY)		
	Lower bound	Base case	Upper bound
Non-high-risk			
18 - 49 y	$526,249	$498,090	$466,186
50 - 64 y	$501,595	$398,809	$306,095
≥65 y	$267,505	$148,811	$81,894
High-risk			
18 - 49 y	$477,426	$375,399	$284,883
50 - 64 y	$368,234	$174,359	$68,386
≥65 y	$157,467	$43,537	Cost-saving

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

Scenario analysis: vaccine dose cost, 2025-2026 vaccination

Age	ICER ($/QALY)					
	$30	$60	$90	$120	Base case	$150
Non-high-risk						
18 - 49 y	$181,113	$268,131	$355,149	$442,166	$498,090	$529,184
50 - 64 y	$121,009	$197,272	$273,535	$349,798	$398,809	$426,061
≥65 y	$25,631	$59,447	$93,262	$127,078	$148,811	$160,894
High-risk						
18 - 49 y	$113,526	$185,417	$257,307	$329,198	$375,399	$401,088
50 - 64 y	$9,490	$54,750	$100,011	$145,272	$174,359	$190,532
≥65 y	Cost-saving	Cost-saving	$13,753	$31,885	$43,537	$50,016

ICER = incremental cost effectiveness ratio; QALY = quality-adjusted life year
Base case: $139.28
Age ≥18 private sector prices: Moderna $141.80; Pfizer $136.75

Accounting for Vaccine Wastage in Cost-effectiveness Analyses

- Few CEAs include wastage as a separate cost in the analysis
- Conventional assumption is that any costs associated with wastage are reflected in the price per dose (if returns are allowed) or the administration fee (if provider bears the cost of unused doses)
- Scenario analysis on price per dose yields insights if wastage is not adequately captured by base case assumptions

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 y only includes those with supplemental insurance
- Evidence base for long COVID is especially scarce
- Model does not include reduced transmission (conservative approach)

Summary

- Vaccination averts morbidity and mortality for all age and risk groups
- Substantial variation in impact by age and risk status
- Overall economic favorability has declined compared to estimates from earlier seasons due to declining burden of illness
- ICERs for ≥65 y age group [HR: $44,000/QALY; NHR: $149,000/QALY] are robust to changes in parameter inputs across plausible ranges [HR: Cost-saving-$142,000/QALY; NHR: $78,000/QALY-$277,000/QALY]
- ICERs for 18-49 y and 50-64 y age groups are sensitive to changes in parameter inputs and favorable only under certain conditions for high-risk 50-64 y

Questions