

Economic analysis of an additional dose of COVID-19 vaccine

University of Michigan
COVID-19 Vaccination Modeling Team

Model updates & additional analysis
February 2024



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Conflict of interest statement

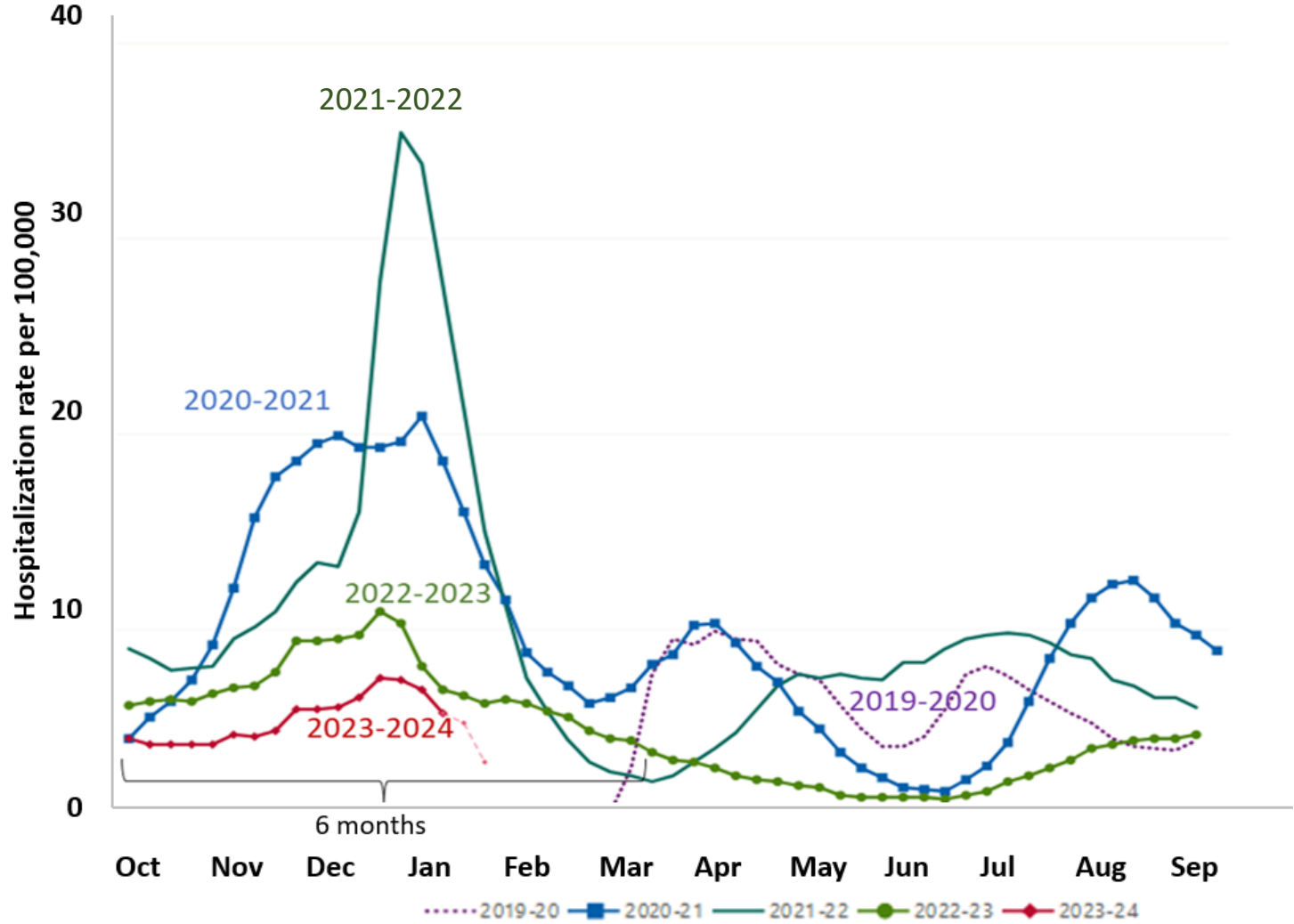
Authors have no known conflicts of interest.

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:
 - Probability of hospitalization: Oct 2022-Sept 2023
 - Adjusted vaccine impact: seasonality
 - 2-dose strategy (an additional mid-year dose)

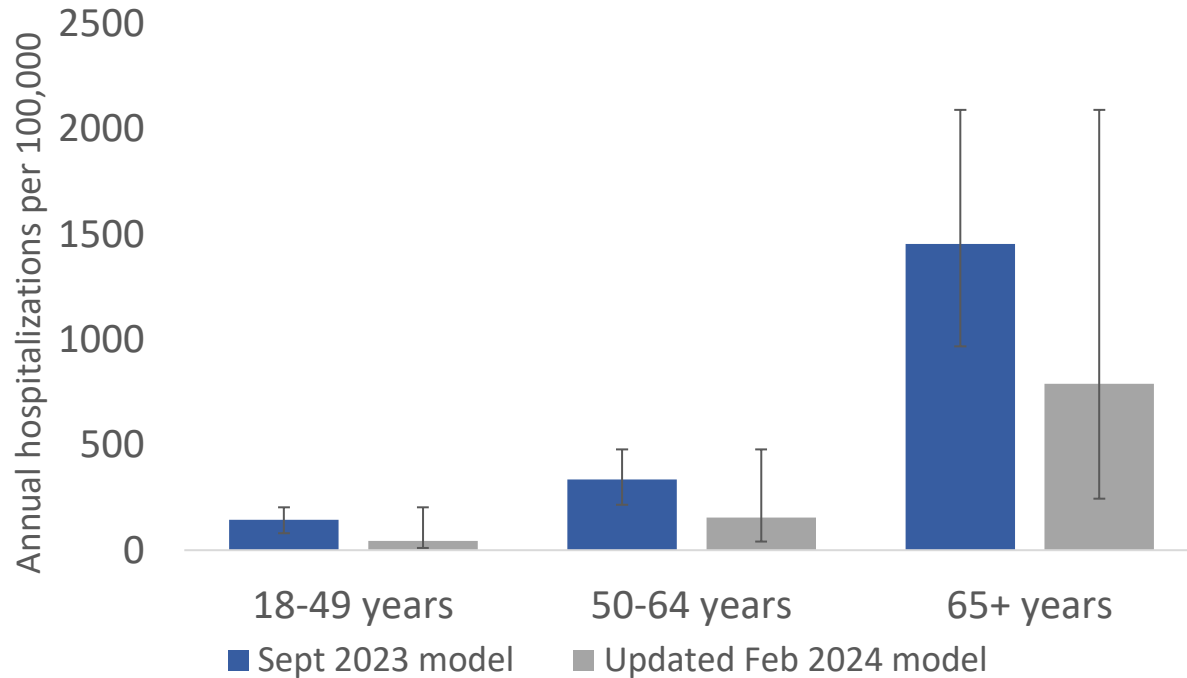
* An earlier analysis from this model was presented to ACIP on September 12, 2023: Prosser, Lisa A. (2023). Economic Analysis of Vaccination with mRNA Booster Dose against COVID-19 Among Adults.

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



Annual probability of hospitalization, by age

Updated to COVID-NET data from Oct 2022-Sept 2023 (table)



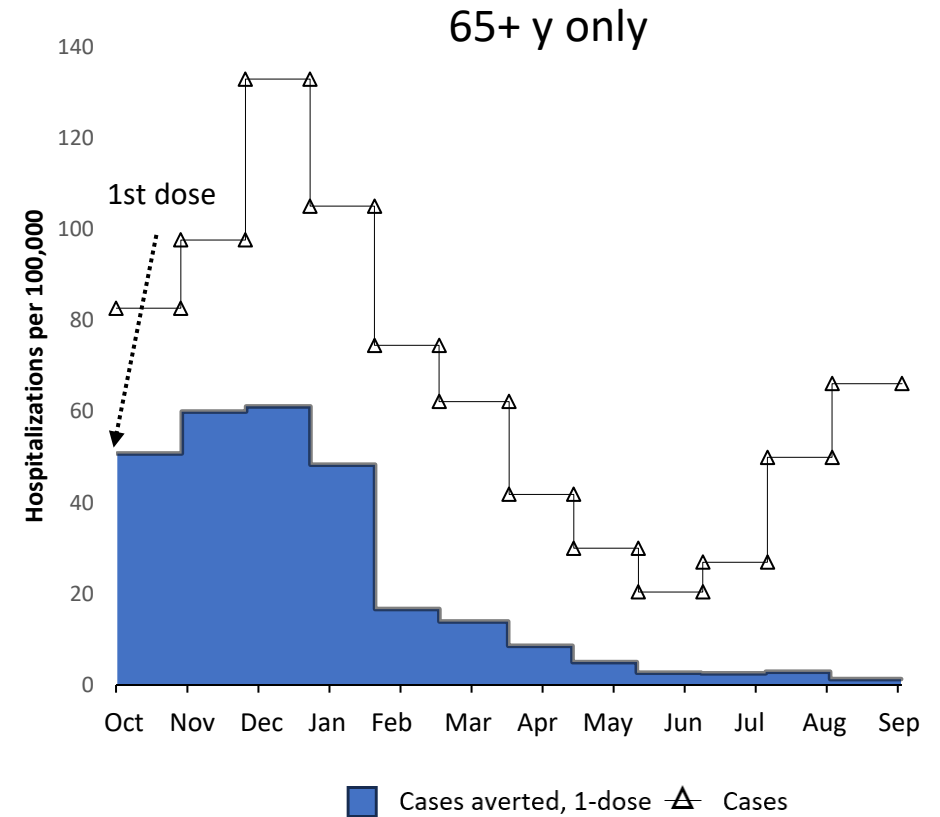
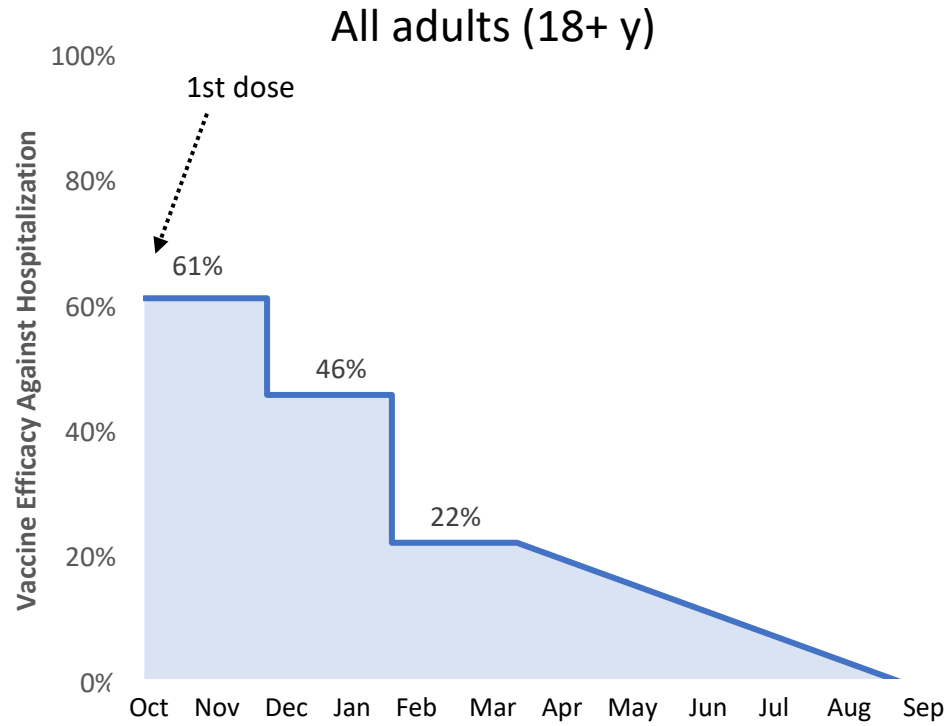
Age group	Base case	Range	
		Low	High*
18-49 y	44	10	204
50-64 y	155	41	479
65+ y	790	245	2090

*Adjusted to include upper limit from Oct 22-Mar 23

Note: Table provides values for updated February 2024 model, reflects rates for patients hospitalized due to COVID-19 as a primary diagnosis

Source: COVID-NET

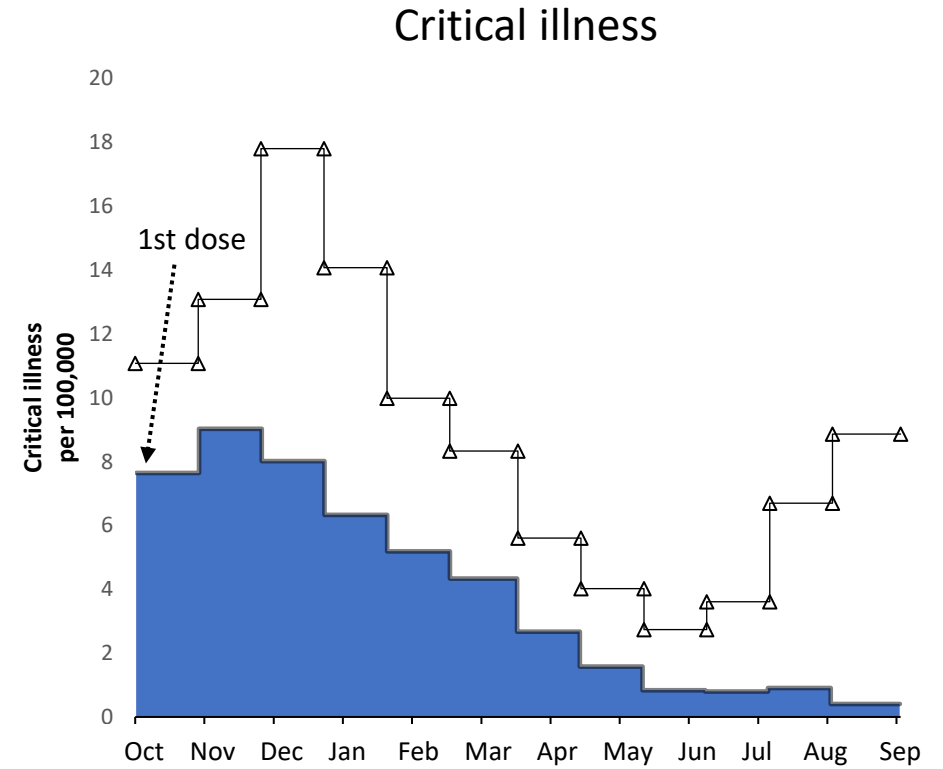
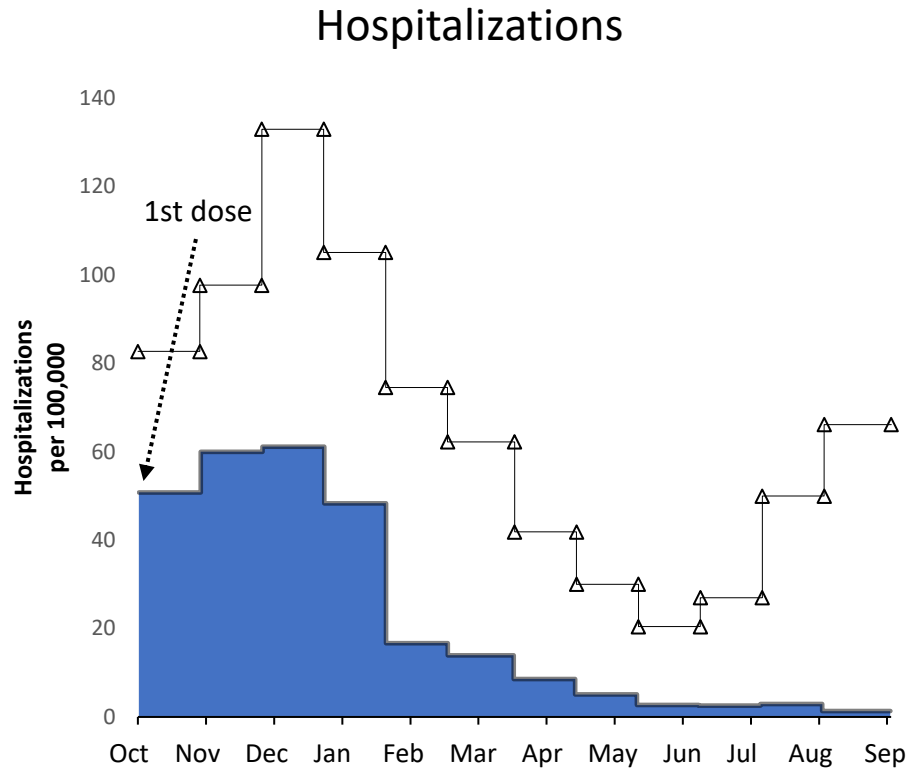
Seasonality-adjusted vaccine impact, 1-dose strategy



Source: COVID-NET, VISION, and IVY

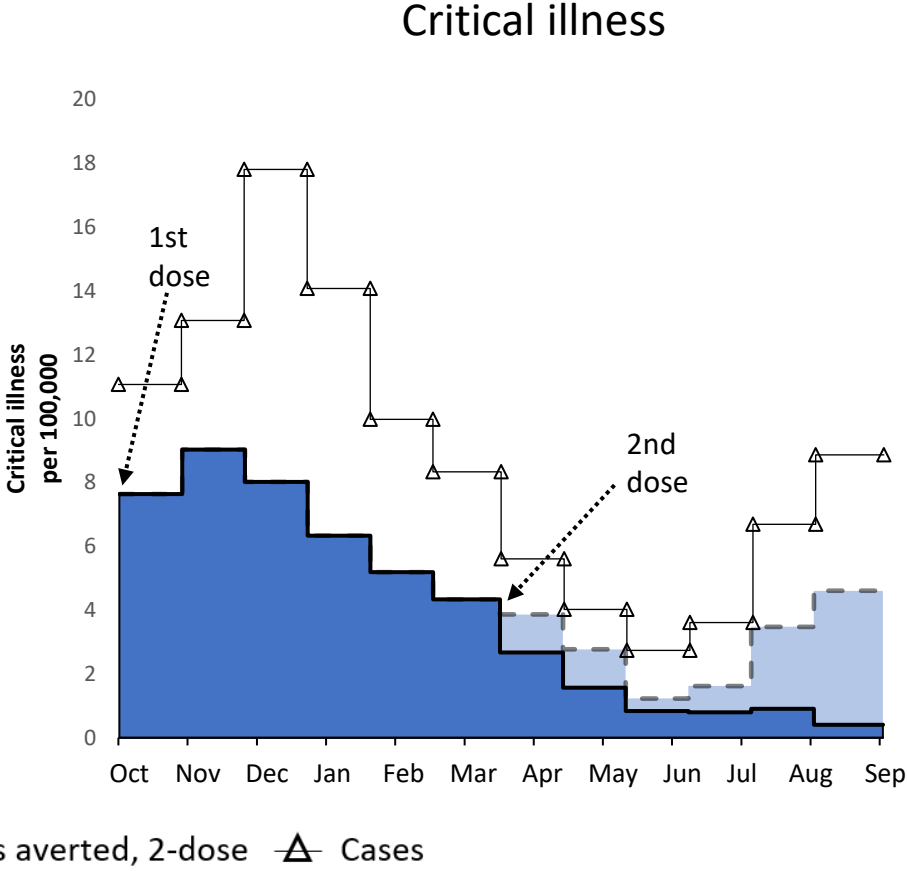
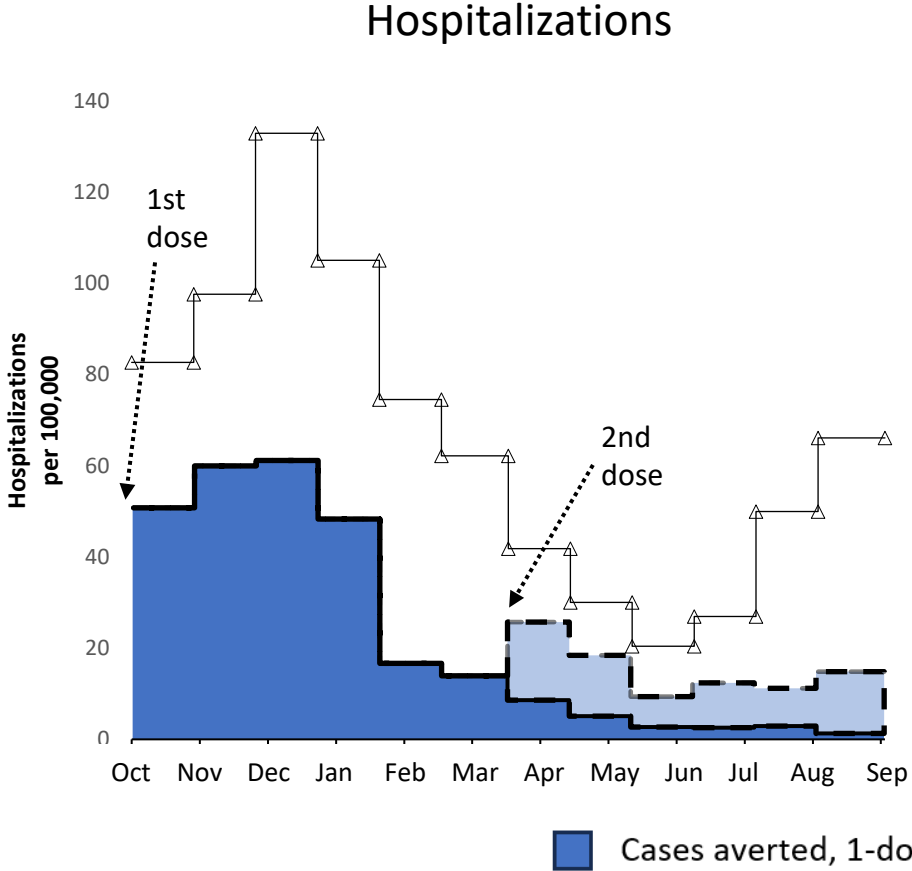
Seasonality-adjusted vaccine impact, 1-dose strategy, 65+ y

8



■ Cases averted, 1-dose ▲ Cases

Seasonality-adjusted vaccine impact, 2-dose strategy, 65+ y



Source: COVID-NET, VISION, and IVY

Updated VE and seasonality-adjusted vaccine impact

	Health outcomes	September 2023 analysis VE				February 2024 analysis* Seasonality-adjusted vaccine impact			
		Age	Base case	Low	High	Age	Base case	Low	High
1-dose strategy	<ul style="list-style-type: none"> Symptomatic illness (non-hospitalized) Hospitalization, uncomplicated 	Pooled 18+ y	0.269	0.088	0.418	65+ y	0.347	0.134	0.468
	<ul style="list-style-type: none"> Critical illness** Death 	Pooled 18+ y	0.403	0.191	0.671	65+ y	0.451	0.272	0.666
2-dose strategy	<ul style="list-style-type: none"> Symptomatic illness (non-hospitalized) Hospitalization, uncomplicated 	Pooled 18+ y	0.428	0.176	0.505	65+ y	0.434	0.179	0.509
	<ul style="list-style-type: none"> Critical illness** Death 	Pooled 18+ y	0.552	0.382	0.672	65+ y	0.549	0.386	0.669

* Updated hospitalization rates Oct 22- Sept 23, seasonality-adjusted vaccine impact

**Hospitalization requiring ICU and/or ventilator assistance

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 supplementary slides 32-33

Analysis Plan

- Updated analysis: Calculate incremental cost-effectiveness ratios comparing updated mRNA booster (1-dose strategy) to no booster, using updated hospitalization and seasonality-adjusted vaccine impact
- Second dose: Conduct base case and uncertainty analyses (one-way sensitivity and scenario analyses) comparing no booster, 1-dose, and 2-dose strategies
- Project disaggregated outcomes stratified by intervention strategy and by age subgroups (18-49y, 50-64y, 65+y) – supplemental slides
 - Cases
 - Hospitalizations
 - Deaths
 - Costs
 - QALYs
 - Adverse events

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

Results

Incremental cost-effectiveness ratios (ICERs), comparison to September 2023 analysis, societal perspective, *preliminary results*

Age	Intervention strategy	ICER (\$/QALY)	ICER (\$/QALY)
		September 2023 analysis	February 2024 analysis
18-49 y	No updated COVID-19 vax	-	-
	Updated COVID-19 vax, 1-dose strategy	\$115,588	\$163,255
50-64 y	No updated COVID-19 vax	-	-
	Updated COVID-19 vax, 1-dose strategy	\$25,787	\$80,427
65+ y	No updated COVID-19 vax	-	-
	Updated COVID-19 vax, 1-dose strategy	Cost-saving	\$11,936

QALY = quality-adjusted life year

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

Age group	Intervention strategy	ICER (\$/QALY)
18-49 y	No updated vax	-
	Updated Covid-19 vax, 1-dose strategy	\$163,255
	Updated Covid-19 vax, 2-dose strategy	\$1,317,714
50-64y	No updated vax	-
	Updated Covid-19 vax, 1-dose strategy	\$80,427
	Updated Covid-19 vax, 2-dose strategy	\$777,612
65+ y	No updated vax	-
	Updated Covid-19 vax, 1-dose strategy	\$11,936
	Updated Covid-19 vax, 2-dose strategy	\$255,122

QALY = quality-adjusted life year

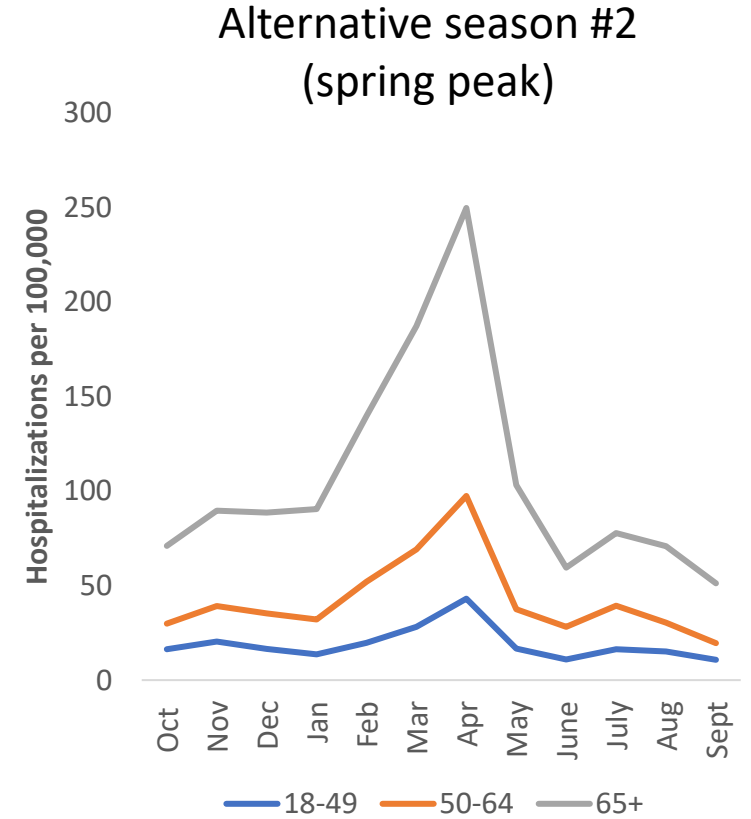
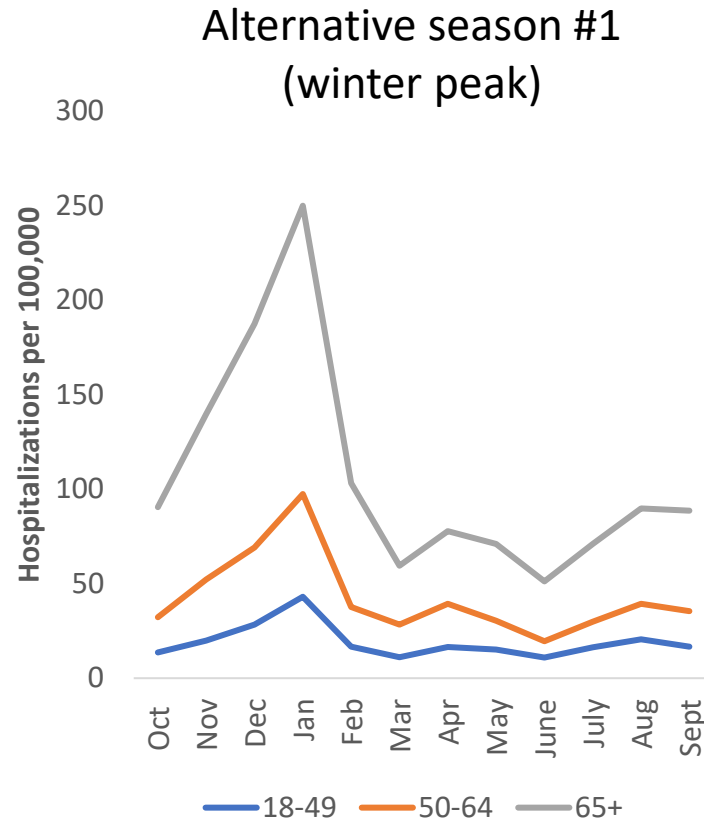
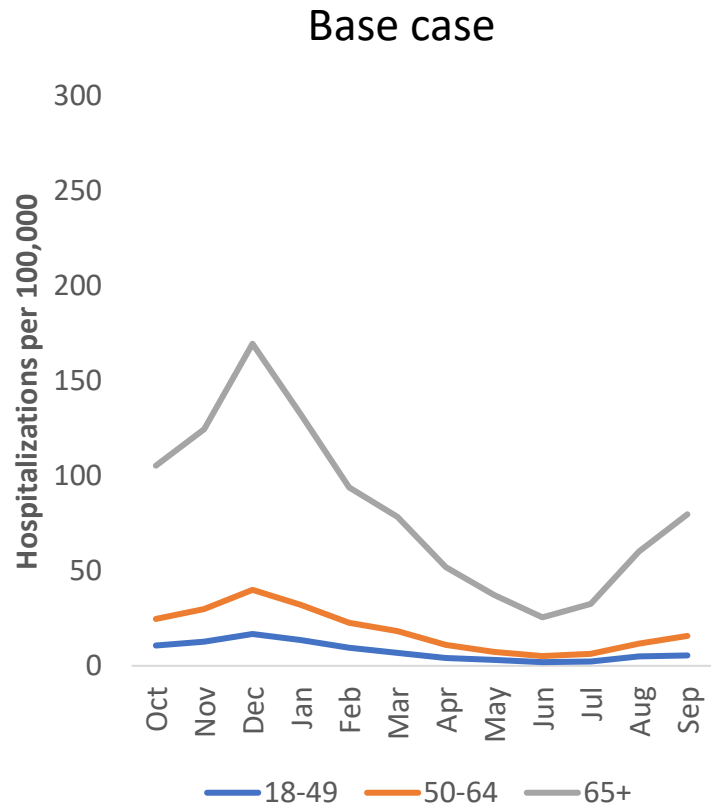
ICERs, 1-way sensitivity analysis, probability of hospitalization, societal perspective, *preliminary results*

Age group	Strategy	ICER (\$/QALY)		
		Base case	Lower bound	Upper bound
18-49 y	Updated Covid-19 vax, 1-dose strategy	\$163,255	\$195,442	\$69,538
	Updated Covid-19 vax, 2-dose strategy	\$1,317,714	\$1,507,831	\$807,114
50-64 y	Updated Covid-19 vax, 1-dose strategy	\$80,427	\$161,605	Cost saving
	Updated Covid-19 vax, 2-dose strategy	\$777,612	\$1,193,501	\$349,971
65+ y	Updated Covid-19 vax, 1-dose strategy	\$11,936	\$81,544	Cost saving
	Updated Covid-19 vax, 2-dose strategy	\$255,122	\$566,141	\$80,182

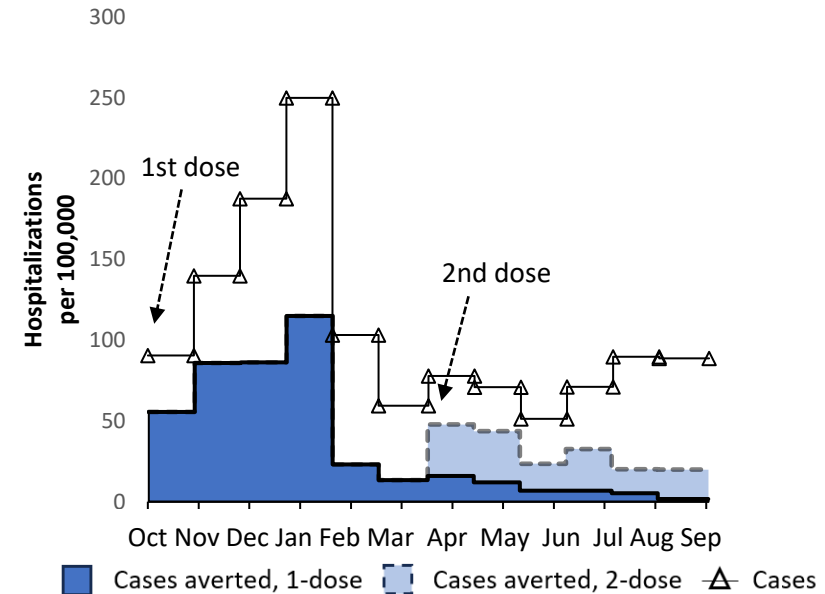
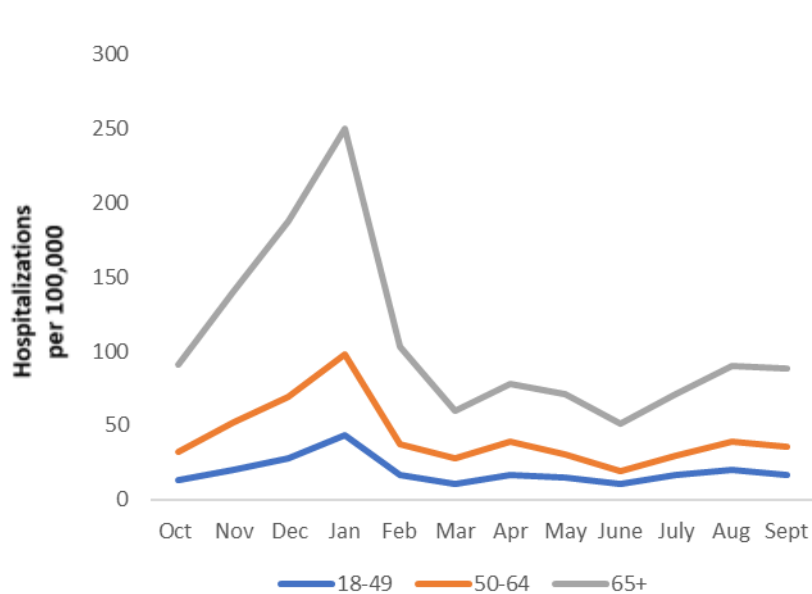
*Probability of hospitalization inputs, base case (range): 18-49 y: 0.000443 (0.000101- 0.00204); 50-64 y: 0.00155 (0.000413 - 0.00479); 65+ y: 0.0079 (0.00245 - 0.0209)

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

Alternative season scenarios

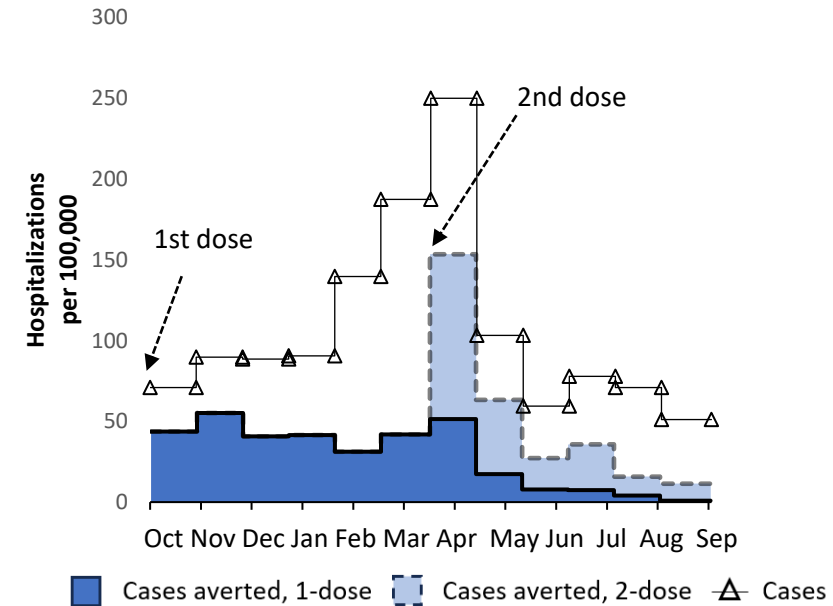
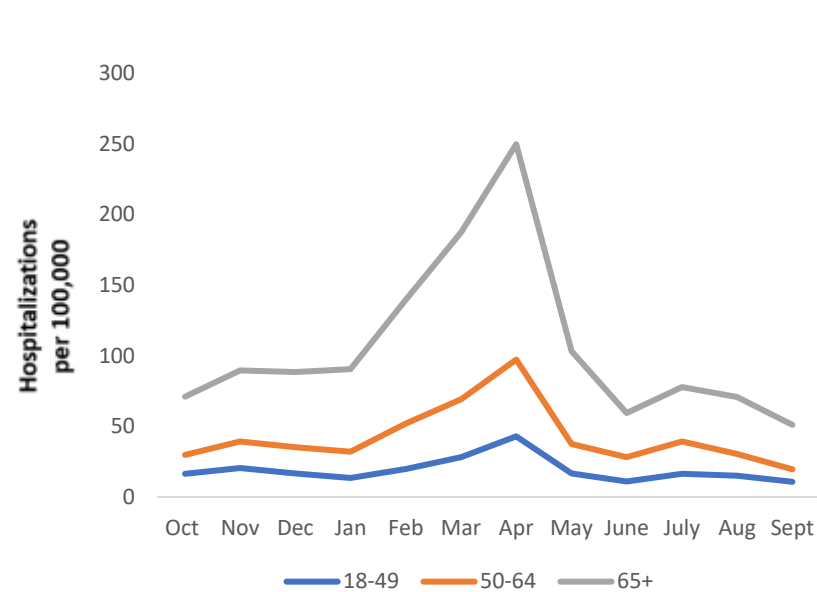


Seasonality-adjusted vaccine impact: alternative season scenario #1 (winter peak)



Health outcomes	Age group	Seasonality-adjusted vaccine impact, alternative scenario #1 (winter peak)					
		1-dose			2-dose		
		Base	Lower	Upper	Base	Lower	Upper
Symptomatic illness and hospitalization	65+ years	0.334	0.121	0.460	0.443	0.181	0.516
Critical care and death		0.432	0.229	0.657	0.540	0.379	0.660

Seasonality-adjusted vaccine impact: alternative season scenario #2 (spring peak)



Health outcomes	Age group	Seasonality-adjusted vaccine impact, alternative scenario #2 (spring peak)					
		1-dose			2-dose		
		Base	Low	High	Base	Low	High
Symptomatic illness and hospitalization	65+ years	0.269	0.070	0.401	0.439	0.194	0.514
Critical care and death		0.444	0.190	0.670	0.571	0.410	0.688

ICERs, scenario analysis varying seasonality, societal perspective, *preliminary results*

Age group	Intervention strategy	Base case ICER \$/QALY	Alternative season #1 (winter peak) ICER (\$/QALY)	Alternative season #2 (spring peak) ICER (\$/QALY)
65+ y	Updated Covid-19 vax, 1-dose strategy	\$11,936	\$14,788	\$25,126
	Updated Covid-19 vax, 2-dose strategy	\$255,122	\$198,802	\$115,650

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

ICER, scenario analysis varying probability of hospitalization*, age 65+, societal perspective, *preliminary results*

Intervention strategy	ICER (\$/QALY)					
	¼ base case (198 per 100,000)	½ base case (395 per 100,000)	Base case (790 per 100,000)	2x base case (1580 per 100,000)	3x base case (2370 per 100,000)	4x base case (3160 per 100,000)
Updated Covid-19 vax, 1-dose	\$93,904	\$52,541	\$11,936	Cost saving	Cost saving	Cost saving
Updated Covid-19 vax, 2-dose	\$624,028	\$433,533	\$255,122	\$120,341	\$64,599	\$34,133

*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 analyses varying vaccination costs, age 65+, societal perspective, *preliminary results*

Varying vaccine dose cost only

Intervention strategy	ICER (\$/QALY)		
	\$20	\$60	Base case \$120
Updated Covid-19 vax, 1-dose strategy	Cost saving	Cost saving	\$11,936
Updated Covid-19 vax, 2-dose strategy	\$72,240	\$145,393	\$255,122

Varying all vaccination-related costs*

Intervention strategy	ICER (\$/QALY)		
	All lower	Base case	All upper
Updated Covid-19 vax, 1-dose strategy	Cost saving	\$11,936	\$53,251
Updated Covid-19 vax, 2-dose strategy	\$50,768	\$255,122	\$443,059

*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 slides 32-33 for input data.

ICER = incremental cost-effectiveness ratio; 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 data on bivalent booster
- 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

- 1-dose strategy, updated inputs (hospitalization, seasonality-adjusted VE)
 - Vaccination averts substantial morbidity and mortality as demonstrated through estimated disaggregated outcomes (supplementary slides)
 - ICERs for 50-64y and 65+ age groups remain robust to changes in parameter inputs across plausible ranges (with a few exceptions)
 - ICERs for 18-49y remain sensitive to changes in parameter inputs; more favorable for higher VE, higher risk of hospitalization, and critical illness
- 2-dose strategy
 - Not economically favorable for 18-49y or 50-64y across plausible parameter ranges
 - For 65+ years, ICERs are sensitive to probability of hospitalization, costs, and seasonality
 - ICERs are more favorable in scenarios with higher risk of hospitalization, lower costs, and alternate seasonality