Economic analysis of an additional dose of COVID-19 vaccine

University of Michigan

COVID-19 Vaccination Modeling Team

Model updates & additional analysis
February 2024

SCHOOL OF PUBLIC HEALTH
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Conflict of interest statement

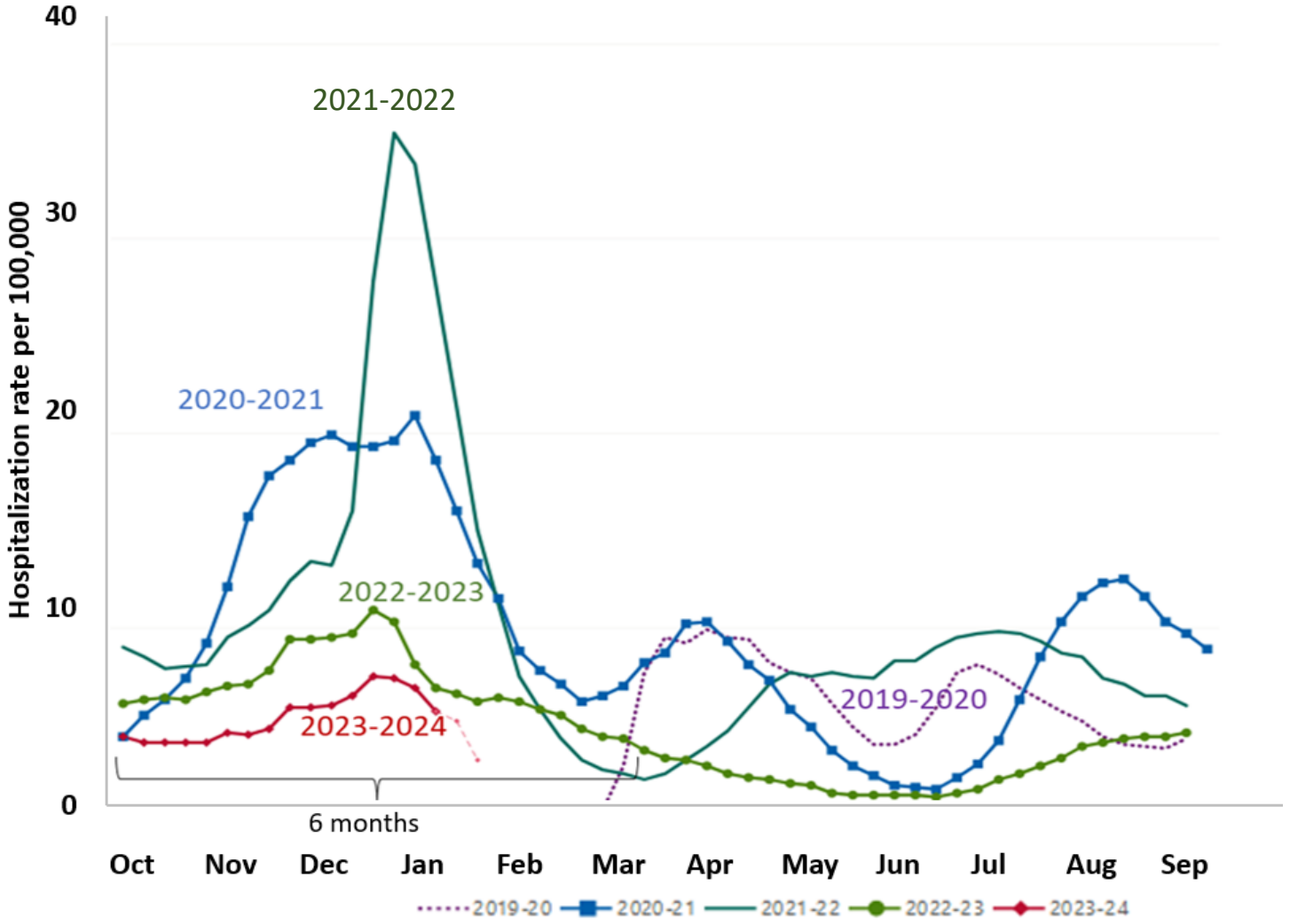
Authors have no known conflicts of interest.

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)

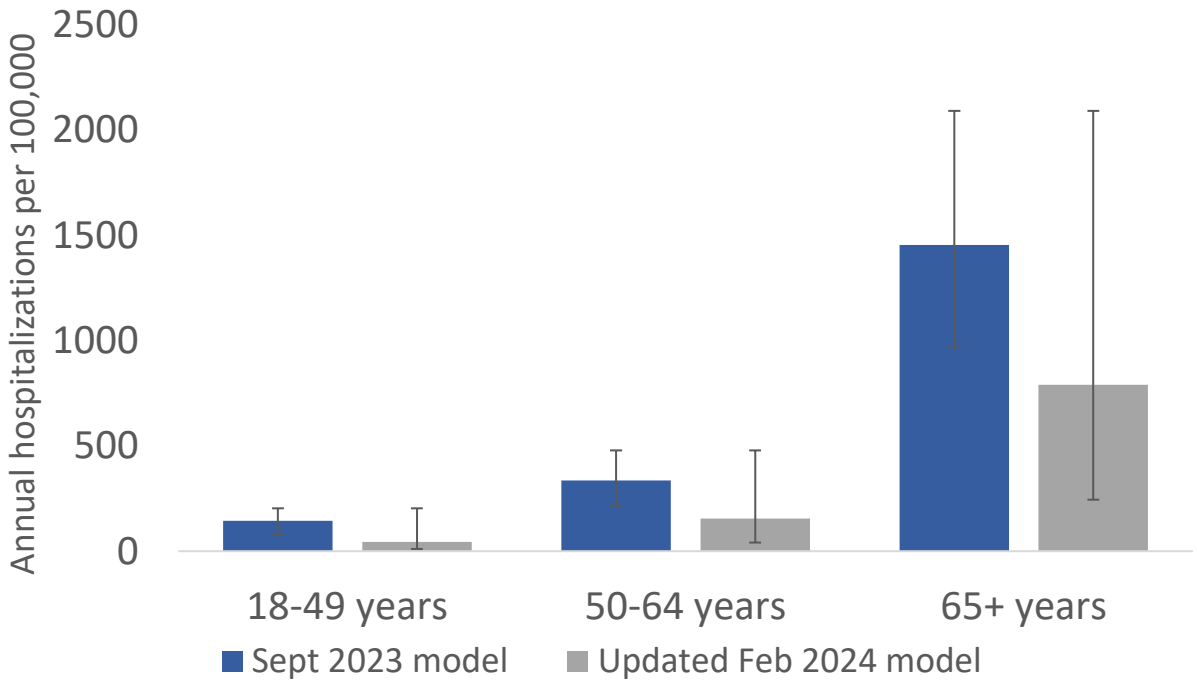
* An earlier analysis from this model was presented to ACIP on September 12, 2023: Prosser, Lisa A. (2023). Economic Analysis of Vaccination with mRNA Booster Dose against COVID-19 Among Adults.

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)

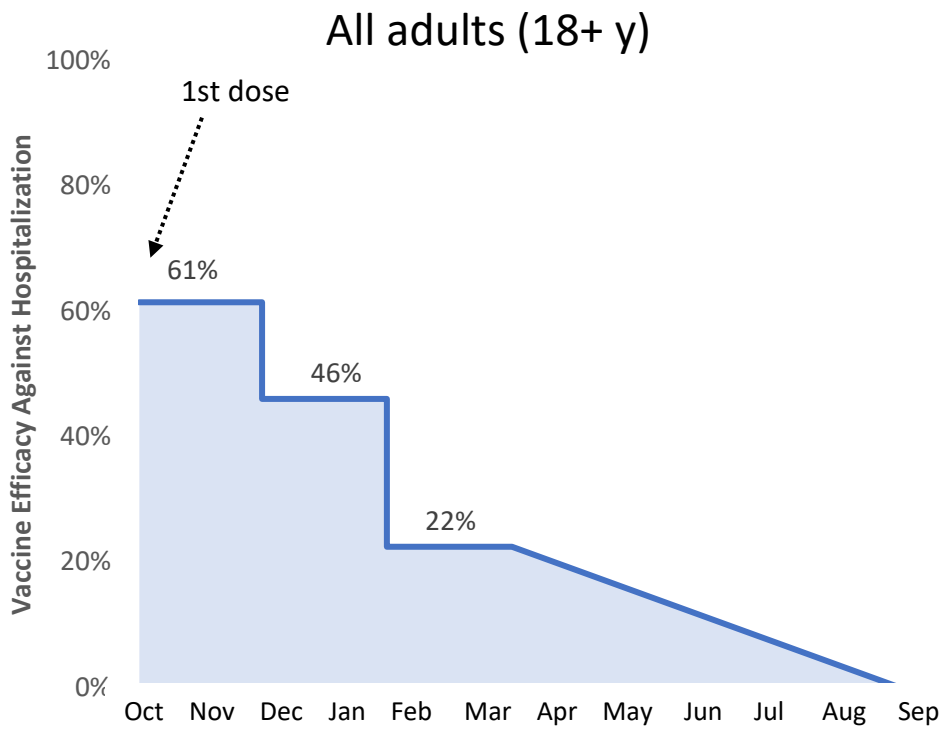


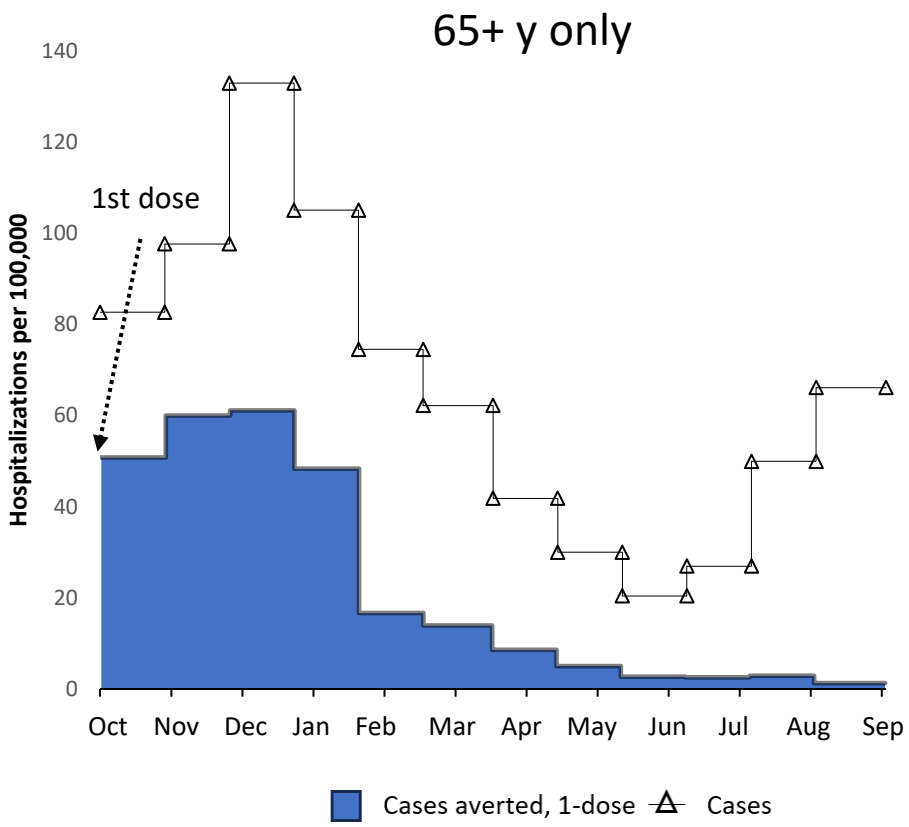
Age group	Base case	Range	
		Low	High*
18-49 y	44	10	204
50-64 y	155	41	479
65+ y	790	245	2090

*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

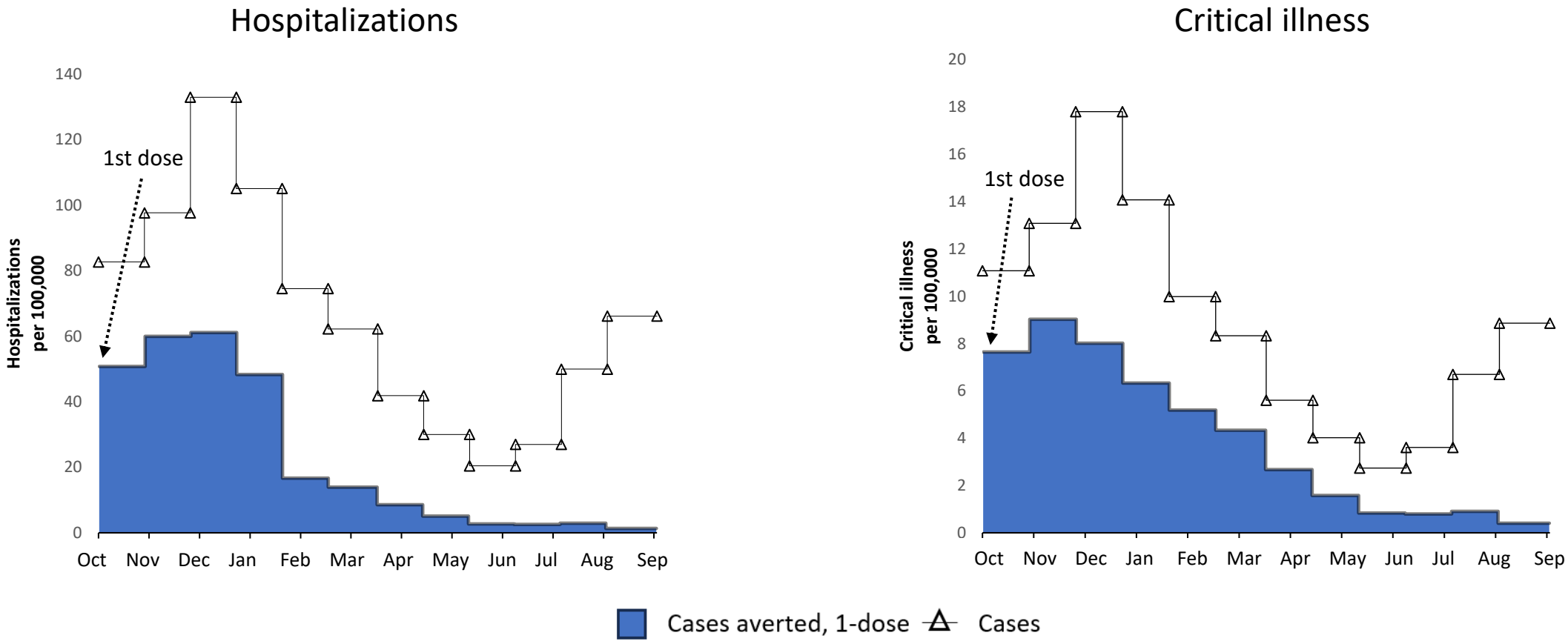
Seasonality-adjusted vaccine impact, 1-dose strategy





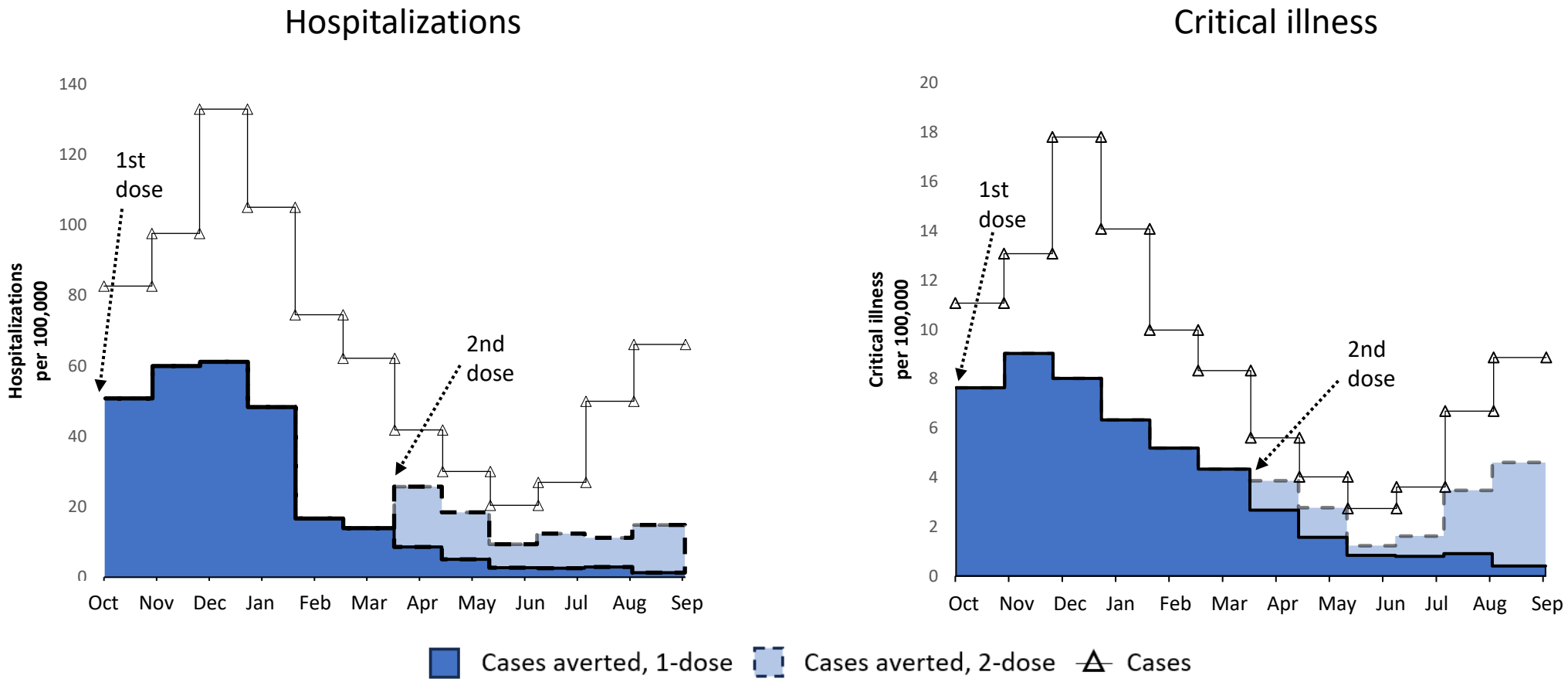
Source: COVID-NET, VISION, and IVY

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



Source: COVID-NET, VISION, and IVY

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	• Symptomatic illness (non-hospitalized) • Hospitalization, uncomplicated	Pooled 18+ y	0.269	0.088	0.418	65+ y	0.347	0.134	0.468
	• Critical illness** • Death	Pooled 18+ y	0.403	0.191	0.671	65+ y	0.451	0.272	0.666
2-dose strategy	• Symptomatic illness (non-hospitalized) • Hospitalization, uncomplicated	Pooled 18+ y	0.428	0.176	0.505	65+ y	0.434	0.179	0.509
	• 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

Source: COVID-NET, VISION, and IVY

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 ($/QALY) September 2023 analysis	ICER ($/QALY) 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*

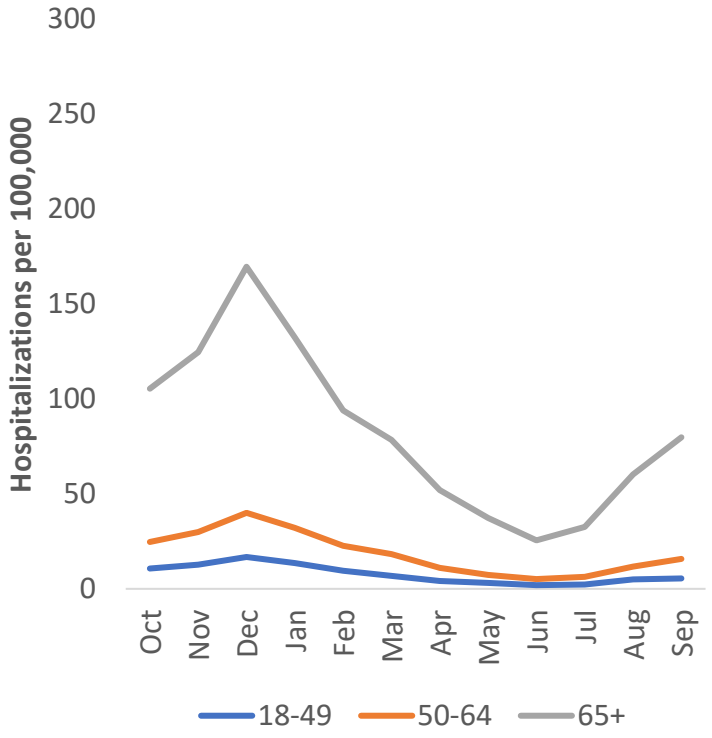
Age group	Strategy	ICER ($/QALY)		
		Base case	Lower bound	Upper bound
18-49 y	Updated Covid-19 vax, 1-dose strategy	$163,255	$195,442	$69,538
	Updated Covid-19 vax, 2-dose strategy	$1,317,714	$1,507,831	$807,114
50-64 y	Updated Covid-19 vax, 1-dose strategy	$80,427	$161,605	Cost saving
	Updated Covid-19 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)

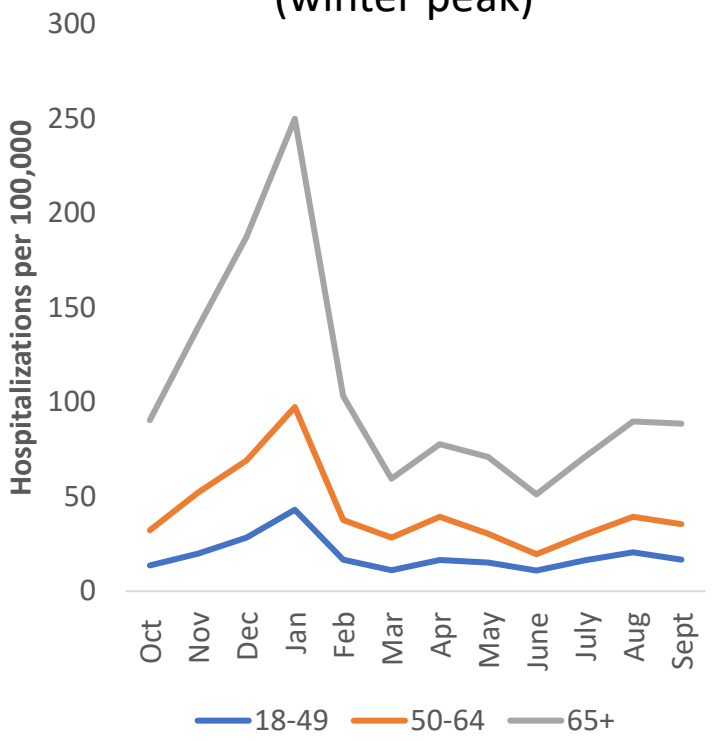
ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year

Alternative season scenarios

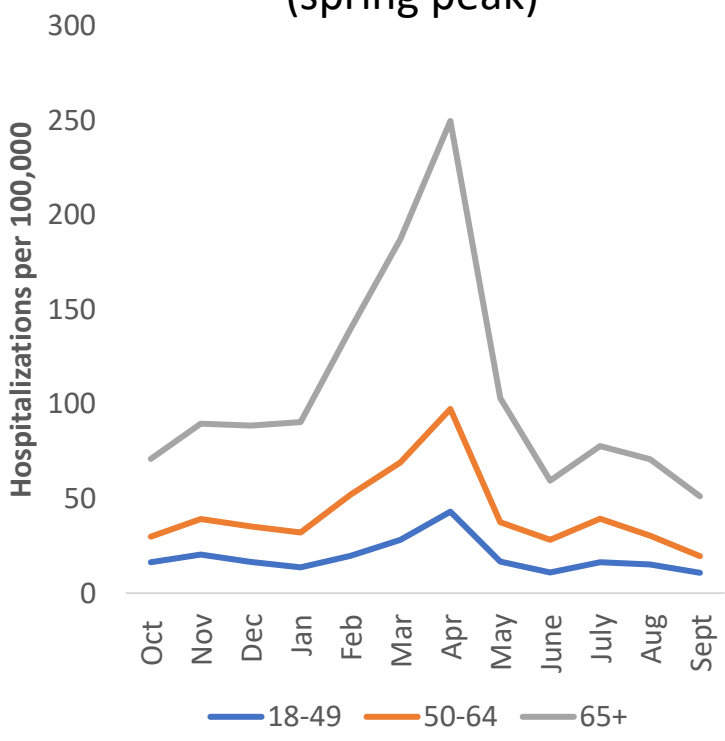
Base case



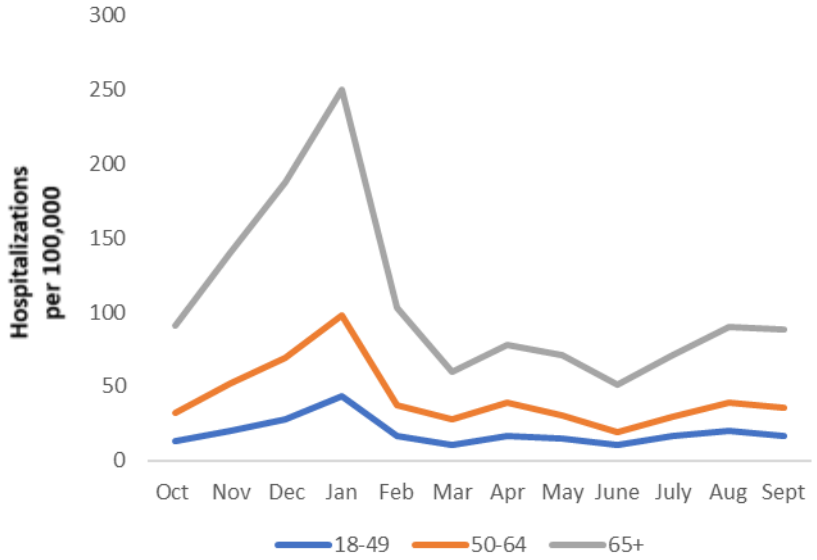
Alternative season #1 (winter peak)

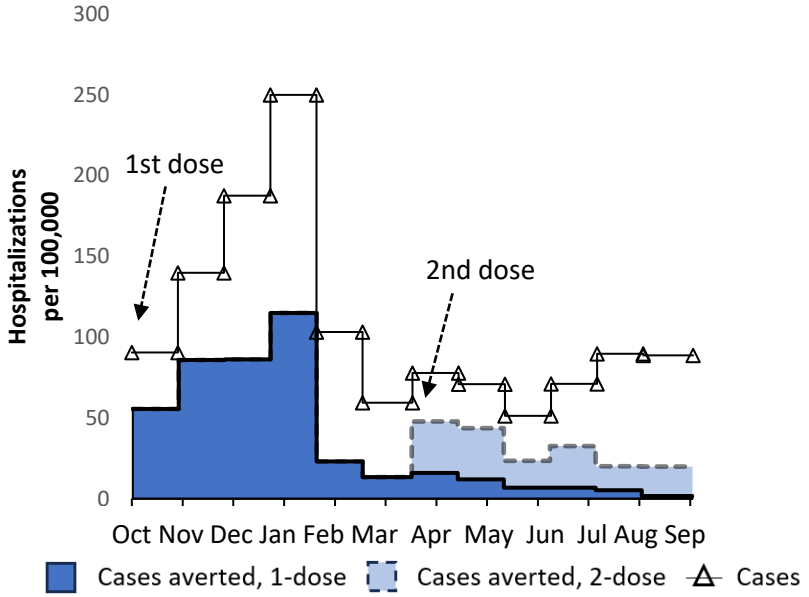


Alternative season #2 (spring peak)



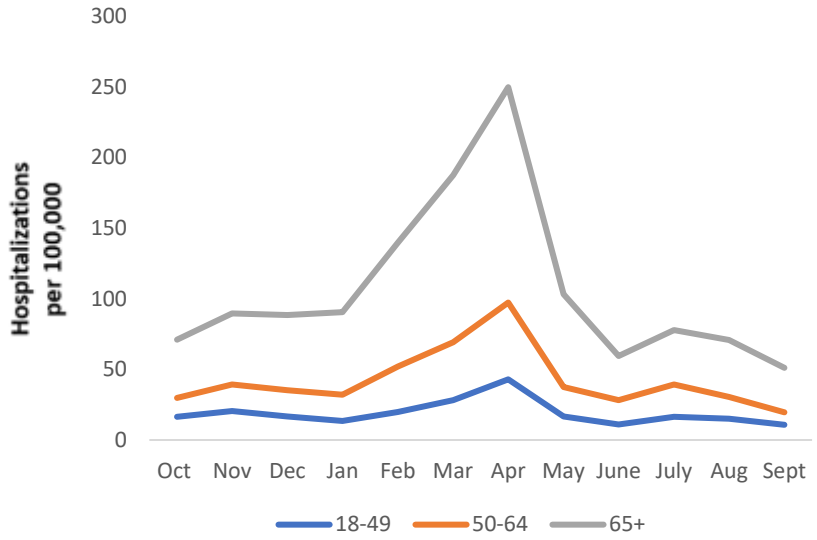
Seasonality-adjusted vaccine impact: alternative season scenario #1 (winter peak)

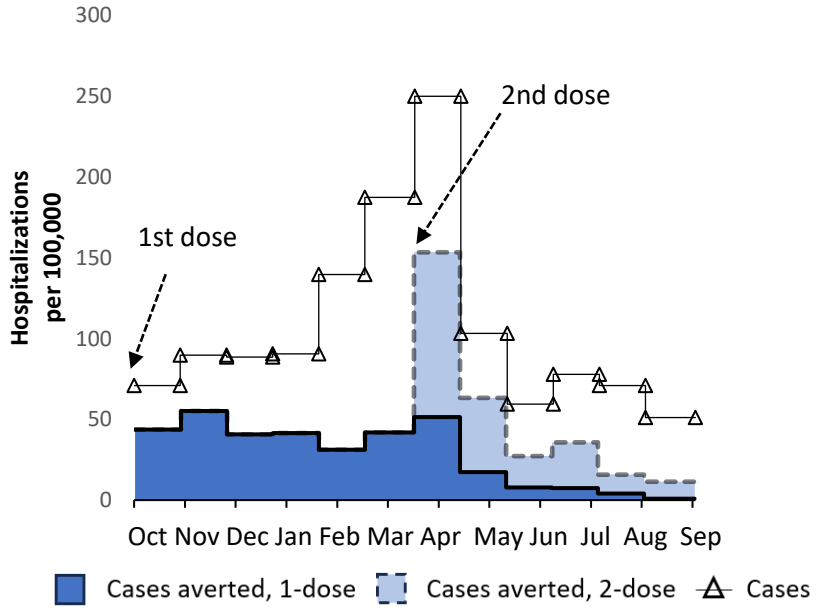




Health outcomes	Age group	Seasonality-adjusted vaccine impact, alternative scenario #1 (winter peak)					
		1-dose			2-dose		
		Base	Lower	Upper	Base	Lower	Upper
Symptomatic illness and hospitalization	65+ years	0.334	0.121	0.460	0.443	0.181	0.516
Critical care and death		0.432	0.229	0.657	0.540	0.379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