Economic Analysis of RSV Vaccination in Older Adults

David W. Hutton, PhD, MS

Associate Professor, Health Management and Policy, School of Public Health

Associate Professor of Global Public Health, School of Public Health

Associate Professor, Industrial and Operations Engineering, College of Engineering

SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF MICHIGAN

University of Michigan

SUSAN B. MEISTER CHILD HEALTH EVALUATION AND RESEARCH CENTER
MICHIGAN MEDICINE

Research Team

University of Michigan

- David Hutton, PhD
- Lisa Prosser, PhD
- Angela Rose, MPH
- Kerra Mercon, MS

CDC

- Michael Melgar, MD
- Mila Prill, MSPH
- Jamison Pike, PhD
- Ismael Ortega-Sanchez, PhD
- Fiona Havers, MD
- Michael Whitaker, MPH
- Christopher Taylor, PhD

Conflicts of interest statements

– No known conflict of interests.

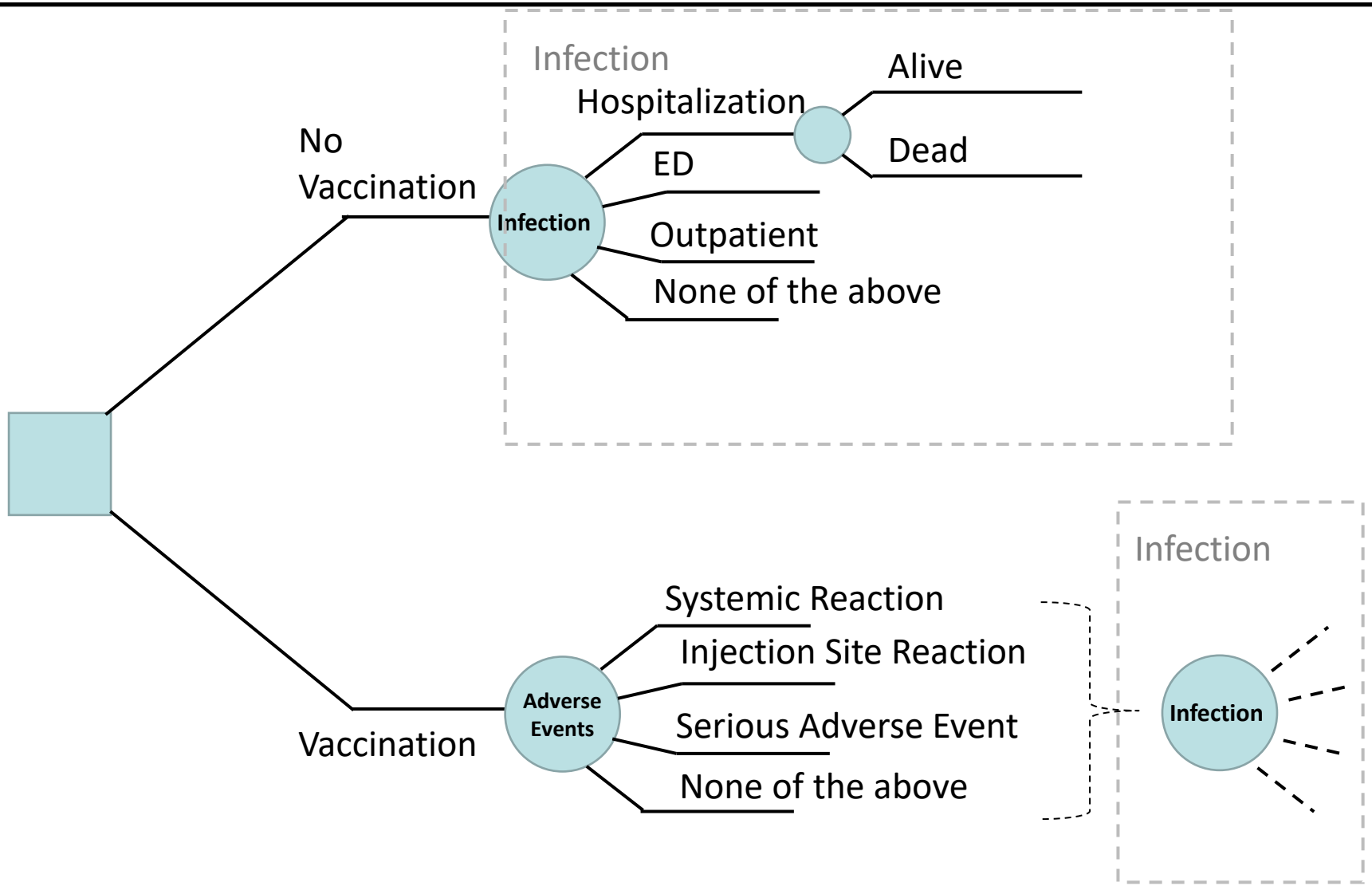
Methods: Study question

- Determine the cost-effectiveness of RSV vaccination by:
  - Evaluating the population burden of disease in the US population
    - ≥60 years old
    - ≥65 years old
    - ≥70 years old
    - ≥75 years old
    - Examining outcomes:
      - resource utilization
      - total cases
      - total costs
      - deaths
      - quality-adjusted life years
  - Comparing vaccination to no vaccination using the incremental cost-effectiveness ratio
  - Scenario analyses exploring uncertainty.
- Perspective: Societal

Methods: Intervention(s)

- Target population: US adults, stratified by age
- Interventions: GSK and Pfizer vaccines
- Each compared to No Vaccination
- Base case assumes the age-based RSV vaccination recommendation is for ages ≥65
- Time horizon: 1 year
- Analytic horizon: lifetime
- Discounting rate: 3%

Methods: Decision Tree Model



Methods: Epidemiology

- Incidence of RSV
  - Raw reported incidence may be underreported because of imperfect PCR sensitivity
    - Base case assumption: 95% sensitivity
    - Additional scenario: lower sensitivity
      - Zhang et al study which found decreased RSV PCR sensitivity when paired serology testing was added as an additional testing method.

Zhang Y, Sakthivel SK, Bramley A, Jain S, Haynes A, Chappell JD, Hymas W, Lenny N, Patel A, Qi C, Ampofo K, Arnold SR, Self WH, Williams DJ, Hillyard D, Anderson EJ, Grijalva CG, Zhu Y, Wunderink RG, Edwards KM, Pavia AT, McCullers JA, Erdman DD. Serology Enhances Molecular Diagnosis of Respiratory Virus Infections Other than Influenza in Children and Adults Hospitalized with Community-Acquired Pneumonia. J Clin Microbiol. 2016 Dec 28;55(1):79-89. doi: 10.1128/JCM.01701-16. PMID: 27795341; PMCID: PMC5228265

Methods: Epidemiology Hospitalization

RSV incidence, per 100,000

Hospitalization

Variable	Value	Range	Source
60≤ age ≤64 years	42	29 – 103	CDC RSVnet
65≤ age ≤74 years	67	48 – 203	
age ≥75 years	193	133 – 575	

- CDC RSVnet data from RSV seasons: 2015-16, 2016-17, 2017-18, and 2018-19.
- Base value is based upon the average burden adjusted rate over those four seasons.
- “burden adjusted” means it is adjusted for a "Standard" PCR test sensitivity of 95%*.
- Range lower bound is based on the lower 95% confidence limit for the base estimates
- Range upper bound is based on the upper 95% confidence limit but also uses a different “burden adjustment” multiplier of 1.4x based on a reduced PCR test sensitivity **

* Kujawski SA, Whitaker M, Ritchey MD, Reingold AL, Chai SJ, Anderson EJ, Openo KP, Monroe M, Ryan P, Bye E, Como-Sabetti K, Barney GR, Muse A, Bennett NM, Felsen CB, Thomas A, Crawford C, Talbot HK, Schaffner W, Gerber SI, Langley GE, Kim L. Rates of respiratory syncytial virus (RSV)-associated hospitalization among adults with congestive heart failure-United States, 2015-2017. PLoS One. 2022 Mar 9;17(3):e0264890. doi: 10.1371/journal.pone.0264890. PMID: 35263382; PMCID: PMC8906631.
** Zhang Y, Sakthivel SK, Bramley A, Jain S, Haynes A, Chappell JD, Hymas W, Lenny N, Patel A, Qi C, Ampofo K, Arnold SR, Self WH, Williams DJ, Hillyard D, Anderson EJ, Grijalva CG, Zhu Y, Wunderink RG, Edwards KM, Pavia AT, McCullers JA, Erdman DD. Serology Enhances Molecular Diagnosis of Respiratory Virus Infections Other than Influenza in Children and Adults Hospitalized with Community-Acquired Pneumonia. J Clin Microbiol. 2016 Dec 28;55(1):79-89. doi: 10.1128/JCM.01701-16. PMID: 27795341; PMCID: PMC5228265.

Methods: Epidemiology
ED and Outpatient

Variable	Value	Range	Source
RSV incidence, per 100,000 ***Emergency Department***			
60≤ age ≤64 years	74	59 – 132	McLaughlin 2022
65≤ age ≤74 years	133	0 – 478	
age ≥75 years	133	0 – 478	
RSV Incidence, per 100,000 ***Outpatient***			
60≤ age ≤64 years	1148	935 – 2041	McLaughlin 2022
65≤ age ≤74 years	1519	1109 – 2893	
age ≥75 years	1519	1109 – 2893	

- McLaughlin et. al. is a Pfizer-sponsored meta-analysis
- Range upper bound is based on the upper 95% confidence limit but also uses the authors' multiplier of 1.5x to adjust for PCR sensitivity

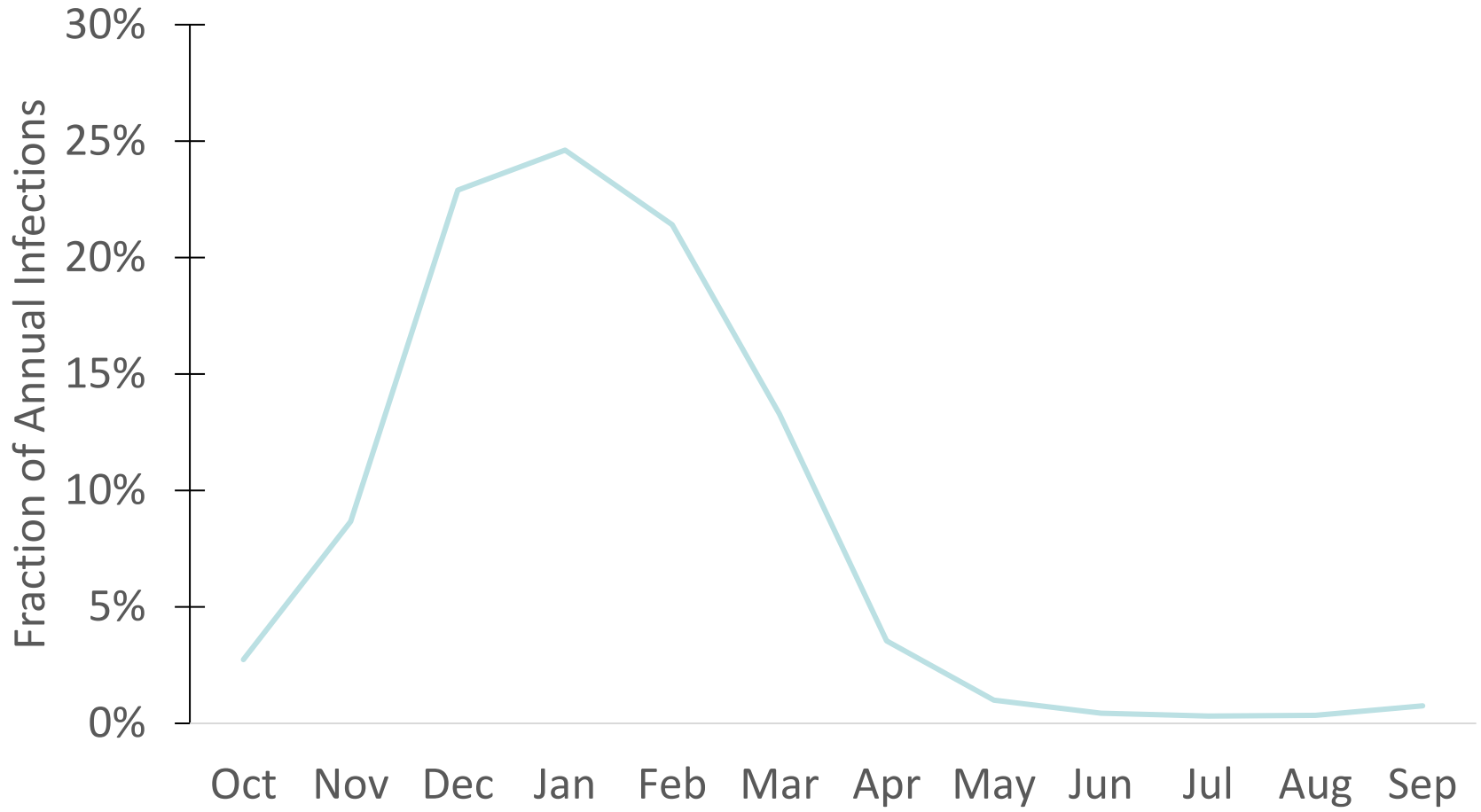
McLaughlin JM, Khan F, Begier E, Swerdlow DL, Jodar L, Falsey AR. Rates of Medically Attended RSV Among US Adults: A Systematic Review and Meta-analysis. Open forum infectious diseases 2022 Jul (Vol. 9, No. 7, p. ofac300).

Methods: Inputs

Variable	Value	Range	Source
RSV mortality per hospitalization			
60≤ age ≤64 years	3.9%	3.12% – 4.68%	CDC RSVnet
65≤ age ≤74 years	4.3%	3.44% – 5.16%	
age ≥75 years	5.7%	4.56% – 6.84%	

CDC RSVnet data includes the following RSV seasons: 2015-16, 2016-17, 2017-18, and 2018-19.
Ranges incorporate a 20% increase/reduction from the base case value

Methods: Incidence Seasonality

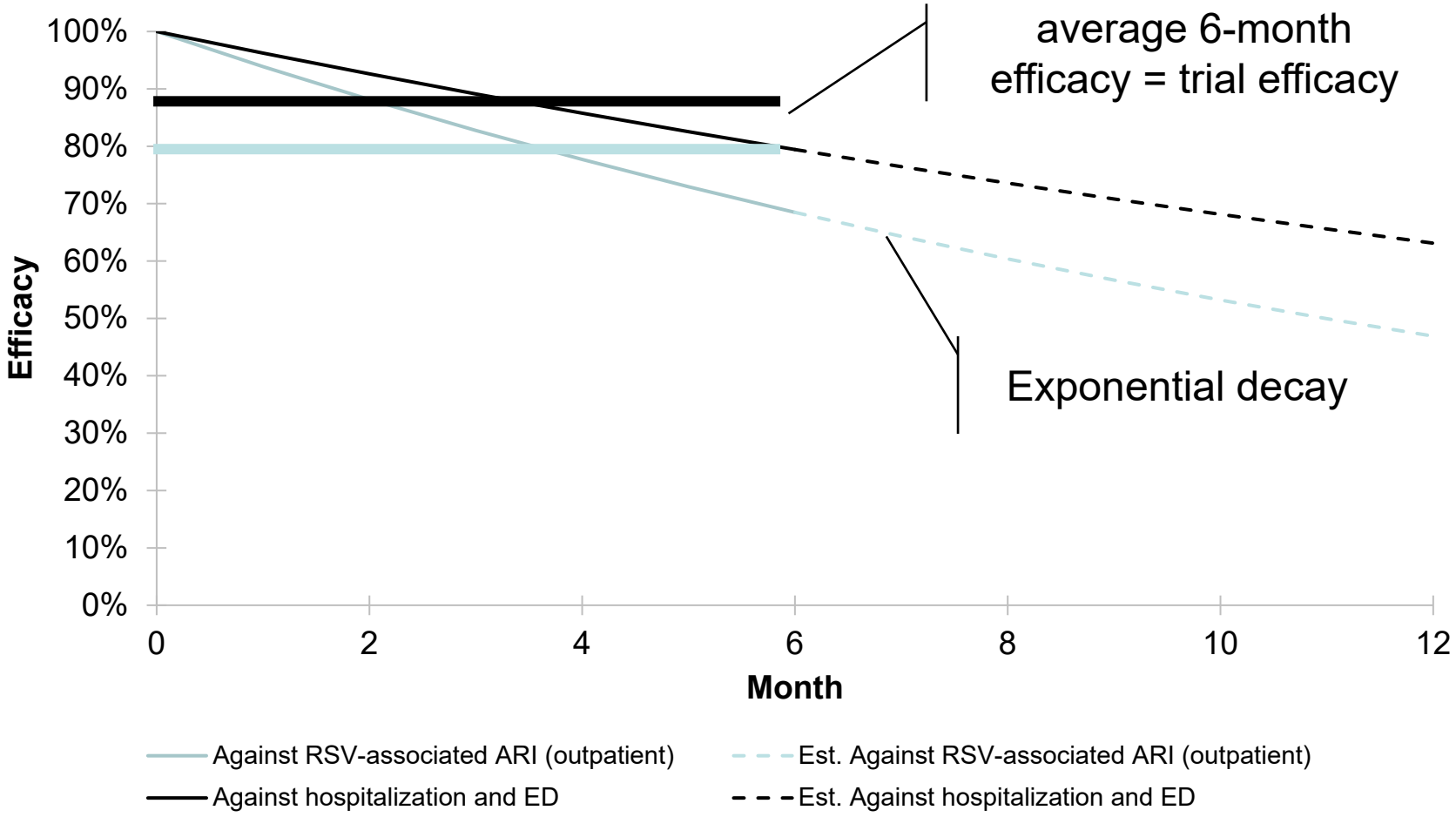


Source: NREVSS (2015-19)

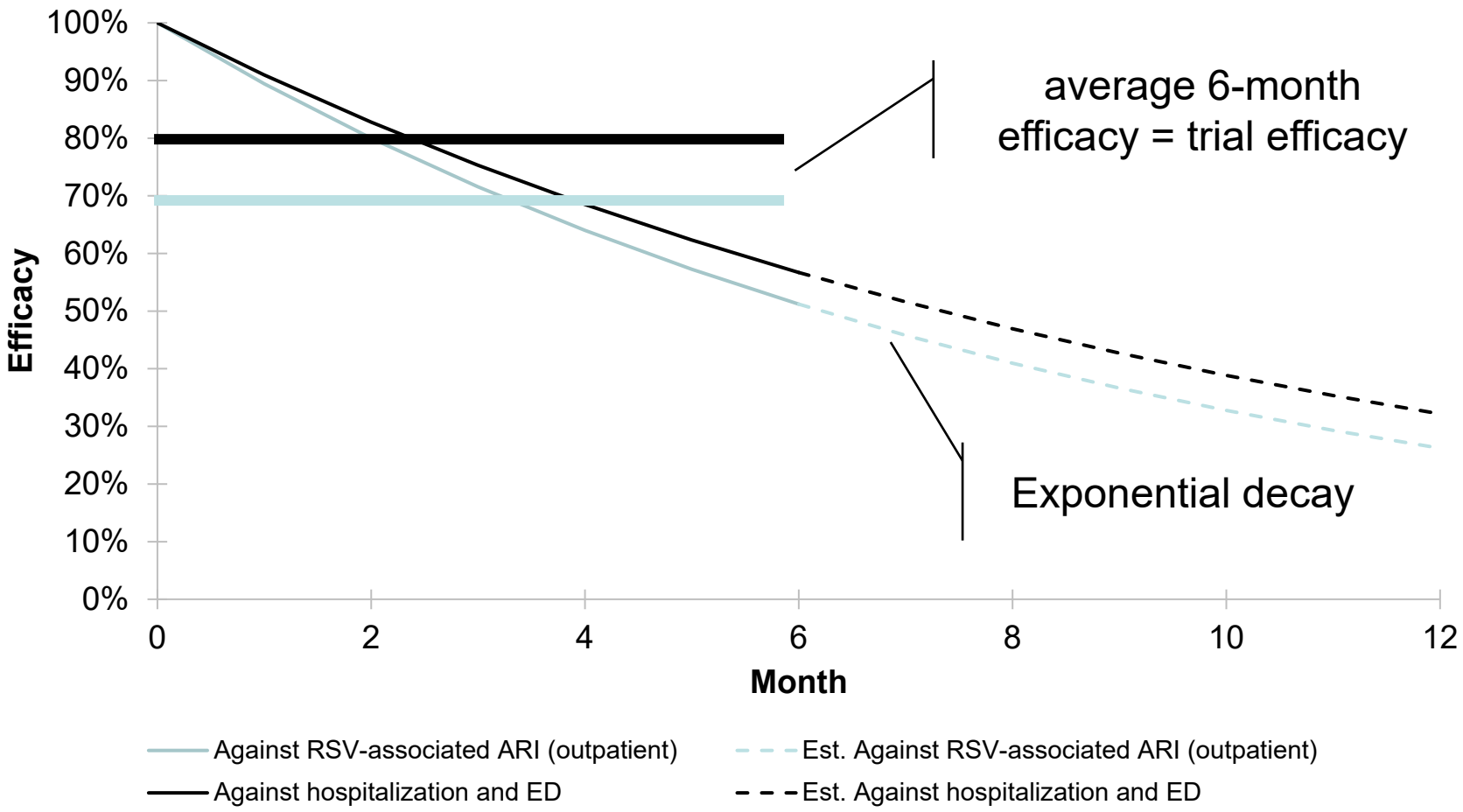
Methods: Efficacy

Variable	Value	Range	Source
Vaccine Efficacy (%)			
GSK			
Medically attended RSV LRTI/LRTD (ED, and hospitalization)	87.5%	58.4% – 96.2%	GSK phase 3 trial
Medically attended RSV ARI (outpatient)	79.0%	54.3% – 91.5%	GSK phase 3 trial
Pfizer			
Medically attended RSV LRTI/LRTD (ED, and hospitalization)	80.0%	6.3% – 97.9%	Pfizer phase 3 trial
Medically attended RSV ARI (outpatient)	69.2%	30.0% – 88.0%	Pfizer phase 3 trial

Efficacy: GSK



Efficacy: Pfizer



Methods: RSV Medical Costs

Variable	Value	Range	Source
Disease-specific hospitalization costs (per hospitalization)			
60≤ age ≤64 years	$20,330	9,288 – 45,454	Ackerson 2020*
65≤ age ≤74 years	$20,330	10,491 – 43,619	
age ≥75 years	$21,339	10,491 – 43,619	
Disease-specific ED costs (per ED visit)			
60≤ age ≤64 years	$1,210	-	2016 Marketscan*
65≤ age ≤74 years	$1,210	-	
age ≥75 years	$1,210	-	
Disease-specific outpatient costs (per outpatient visit)			
60≤ age ≤64 years	$117.58	65.88-145.38	MarketScan and Medicare FFS, 2020-2021
65≤ age ≤74 years	$100.86	50.48-120.08	
age ≥75 years	$100.86	50.48-120.08	

*Updated to Q3 2022$ using GDP Deflator

Methods: Vaccination-Related Costs

Variable	Value	Range	Source
Vaccine, per dose	$100	$50-$200	Assumption
Vaccine administration	$16.96	-	HCPCS 90460 (Physician Fee Schedule 2022)

And productivity costs for individuals time at clinic or pharmacy

Methods: RSV Health-Related Quality-of-Life

Variable	Value	Range	Source
QALYs lost due to			
Outpatient RSV	0.0185	0.0053-0.0347	JIVE COVID/RSV utilities study (unpublished)
Hospitalized RSV	0.0193	0.0095-0.0316	

Methods: Additional Inputs

- Also included
  - RSV illness productivity costs
  - Vaccination productivity costs
  - Vaccination adverse events
    - Systemic reactions
    - Injection site reactions
    - Serious adverse events
    - Medical costs
    - Productivity costs

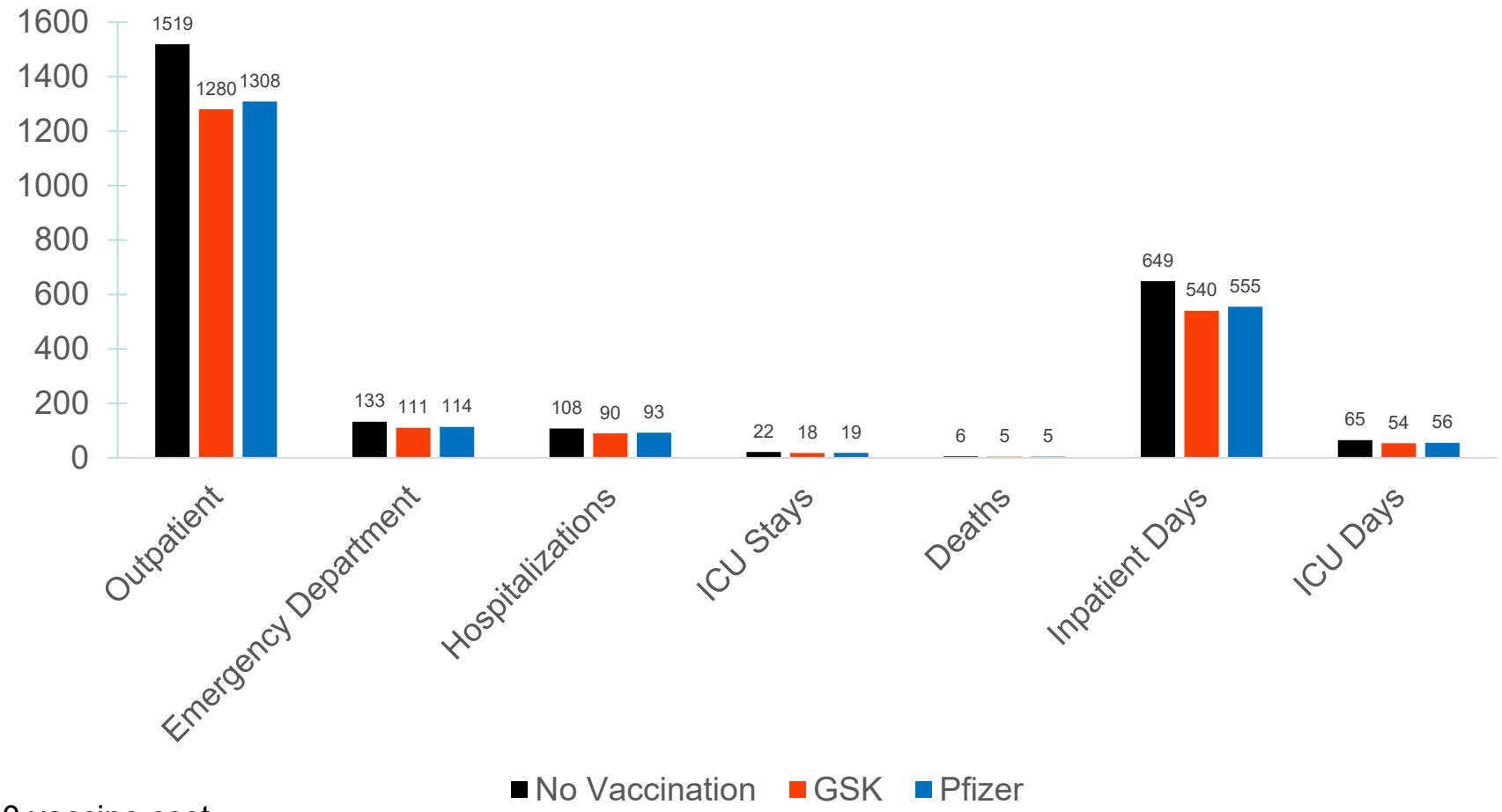
Methods: Sensitivity analyses

- Sensitivity analyses conducted
  - One-Way and Two-Way
  - Age-based recommendation for RSV vaccination
    - age ≥60 years
    - age ≥65 years
    - age ≥70 years
    - age ≥75 years
  - Vaccine cost
    - $50-$200
- Scenario analysis: Higher incidence

Results: Base Case

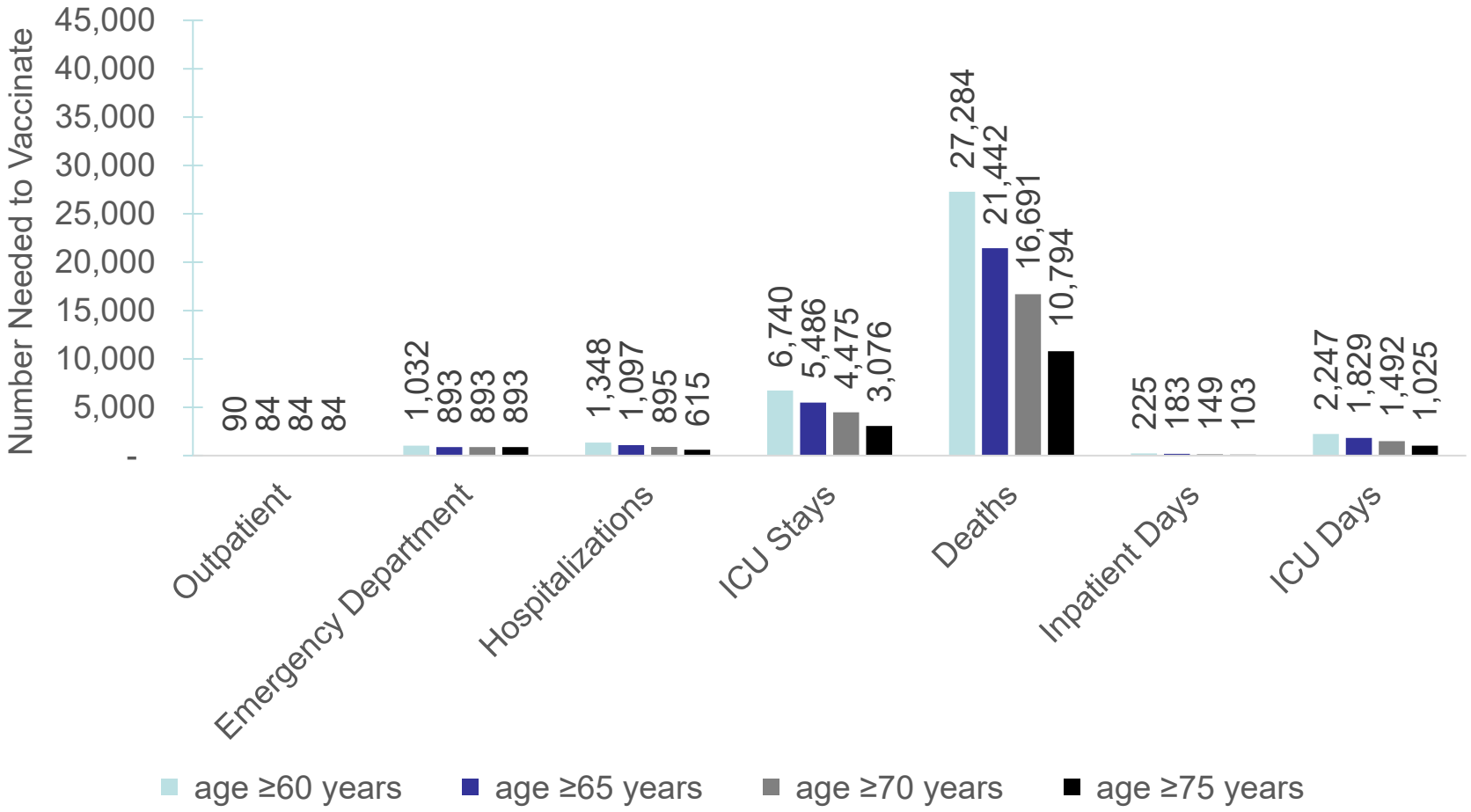
- Cohort of 100,000
- 20% vaccination coverage
- Age-based vaccination recommendation: ≥65 years
- $100 vaccine cost
- One Year Time Horizon

Health Outcomes



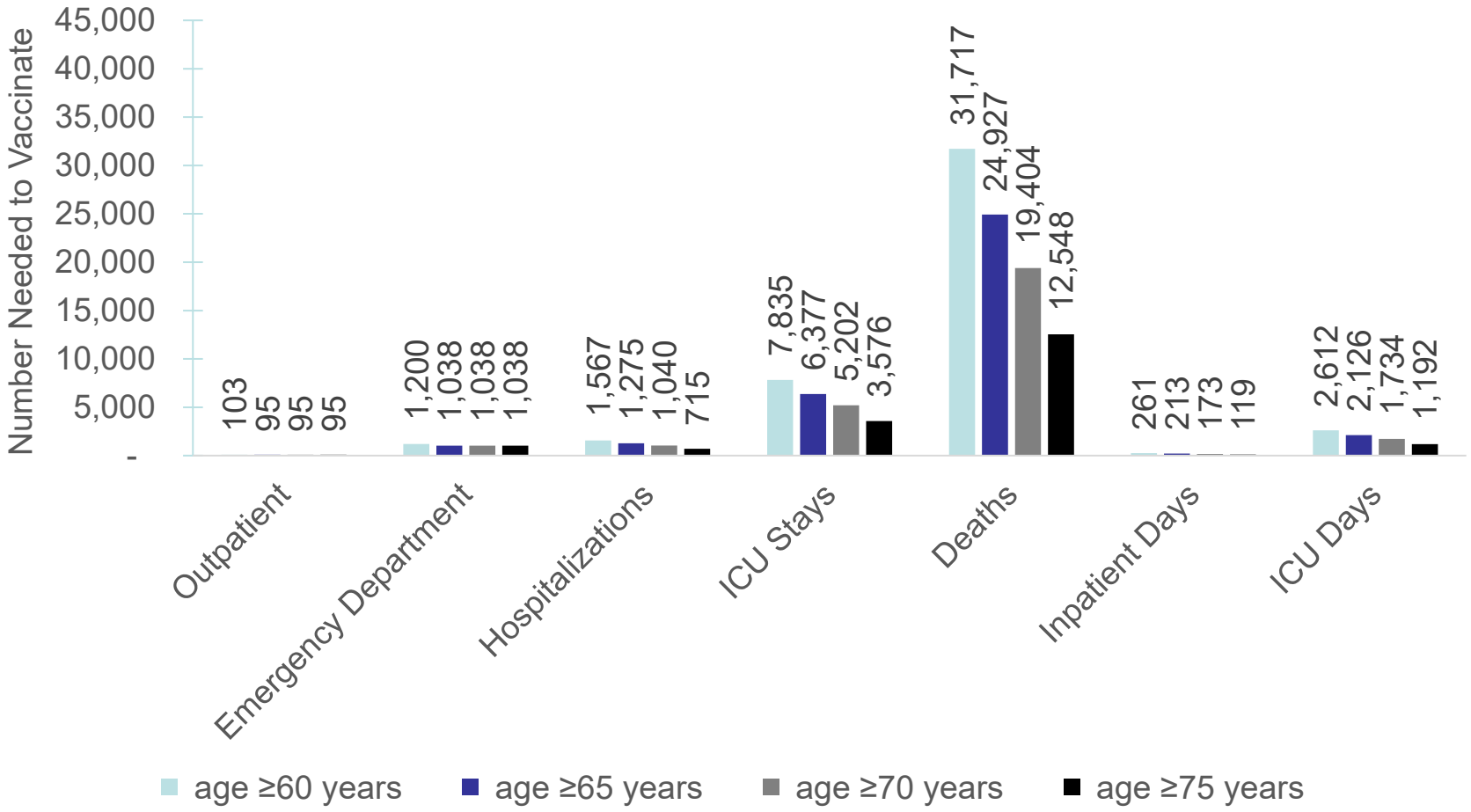
$100 vaccine cost
One Year Time Horizon
Cohort:100,000, 20% uptake
Age-based vaccination recommendation: ≥65 years

Number Needed to Vaccinate, GSK



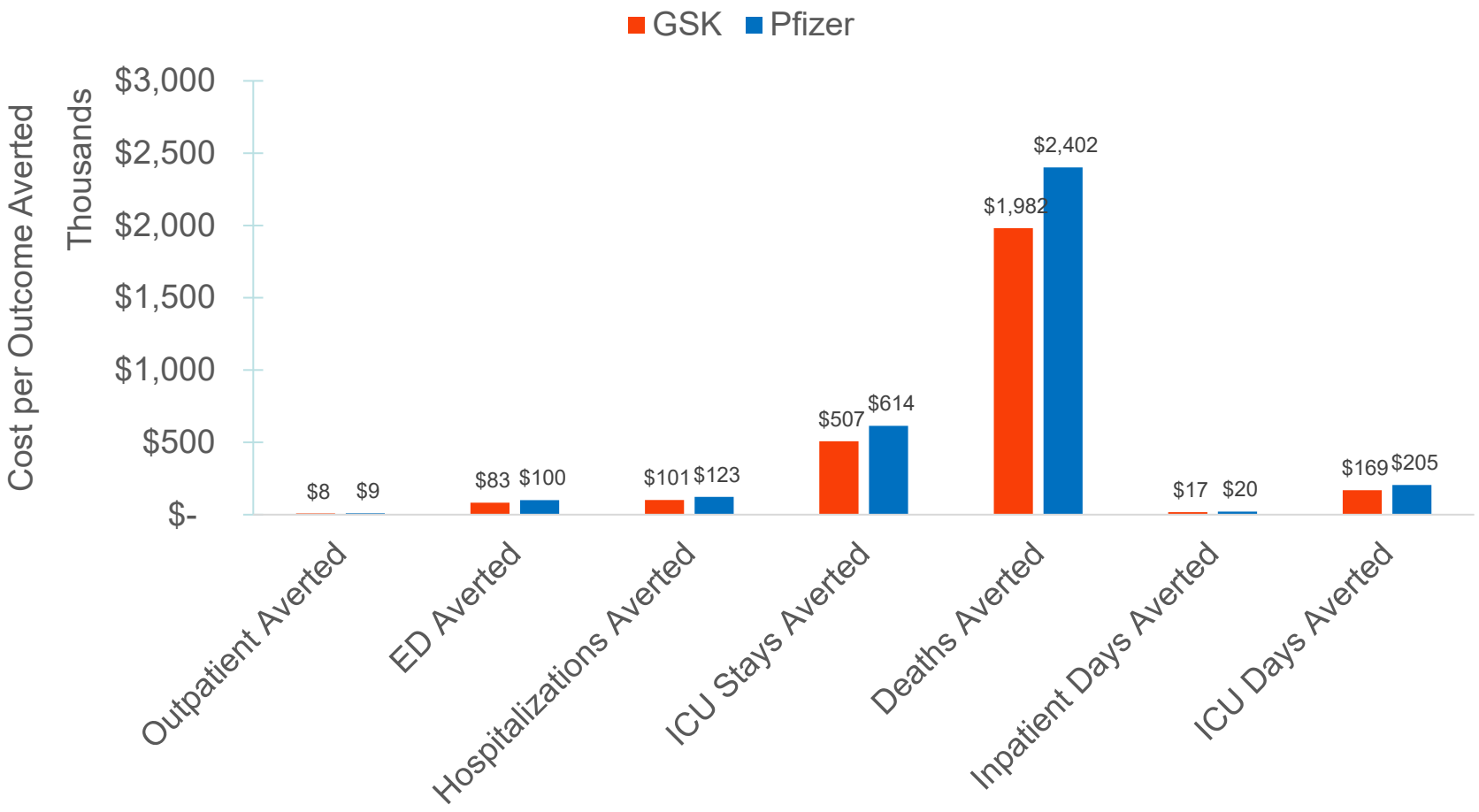
One Year Time Horizon

Number Needed to Vaccinate, Pfizer



One Year Time Horizon

Cost per Outcome Averted ($ thousands)



$100 vaccine cost
One Year Time Horizon
Age-based vaccination recommendation: ≥65 years

Summary measure(s)
GSK

	Costs (M)	QALYs Lost	ICER ($/QALY)	LYs Lost	ICER ($/LY)
No Vaccination	3.75	75		55	
Vaccine	5.59	64	180,720	46	198,676

QALY = Quality-Adjusted Life-Year
ICER = Incremental Cost-Effectiveness Ratio
LY = Life-Year
Cost, QALY, and LY Results per 100,000 (20% of whom are vaccinated)
Costs in Millions of 2022 dollars
ICER values do not depend on cohort size or uptake
$100 vaccine cost
One Year Time Horizon
Age-based vaccination recommendation: ≥65 years

Summary measure(s)
Pfizer

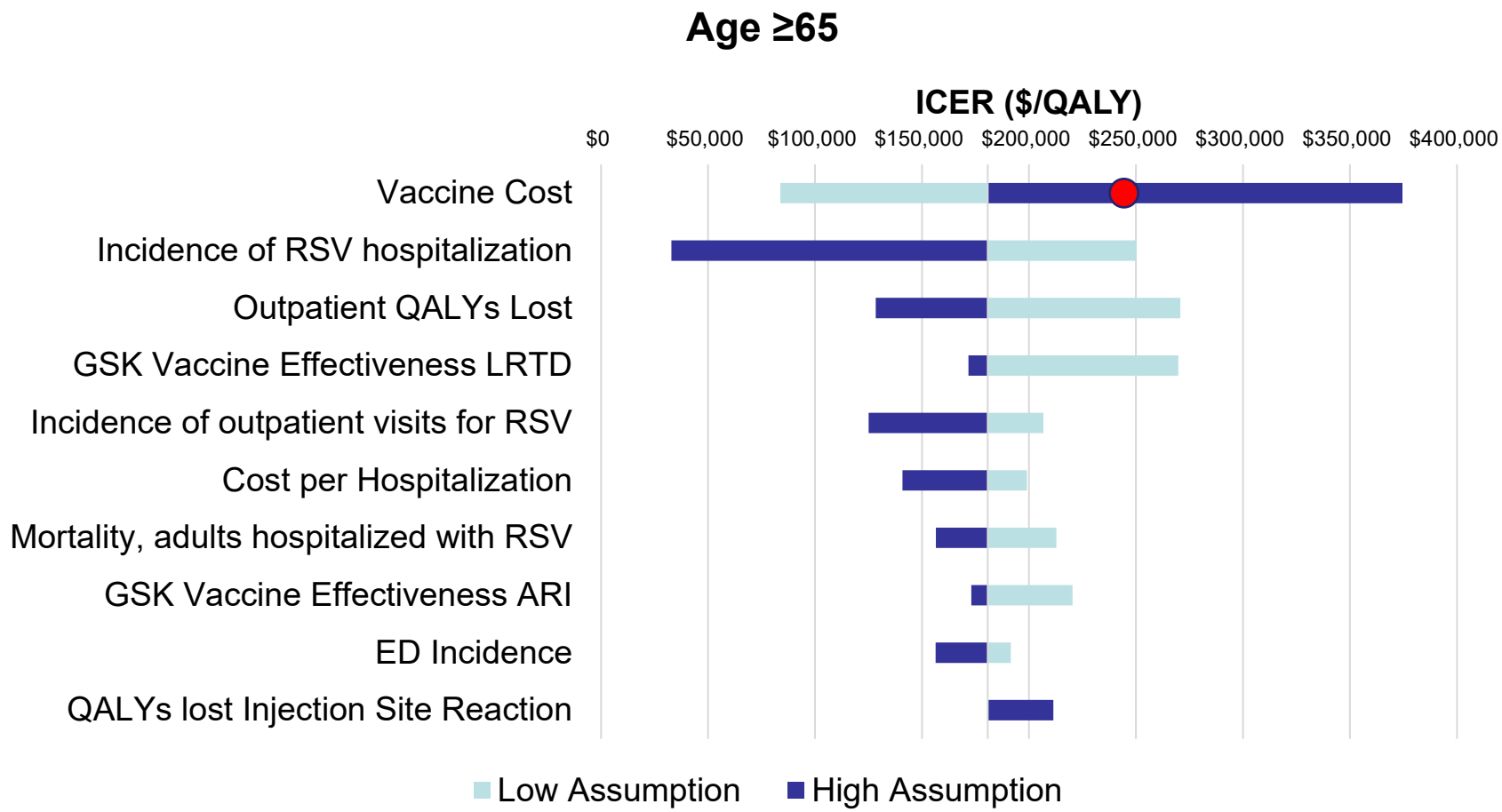
	Costs (M)	QALYs Lost	ICER ($/QALY)	LYs Lost	ICER ($/LY)
No Vaccination	3.75	75		55	
Vaccine	5.67	64	189,407	47	240,699

QALY = Quality-Adjusted Life-Year
ICER = Incremental Cost-Effectiveness Ratio
LY = Life-Year
Cost, QALY, and LY Results per 100,000 (20% of whom are vaccinated)
Costs in Millions of 2022 dollars
ICER values do not depend on cohort size or uptake
$100 vaccine cost
One Year Time Horizon
Age-based vaccination recommendation: ≥65 years

Results: Sensitivity analyses,

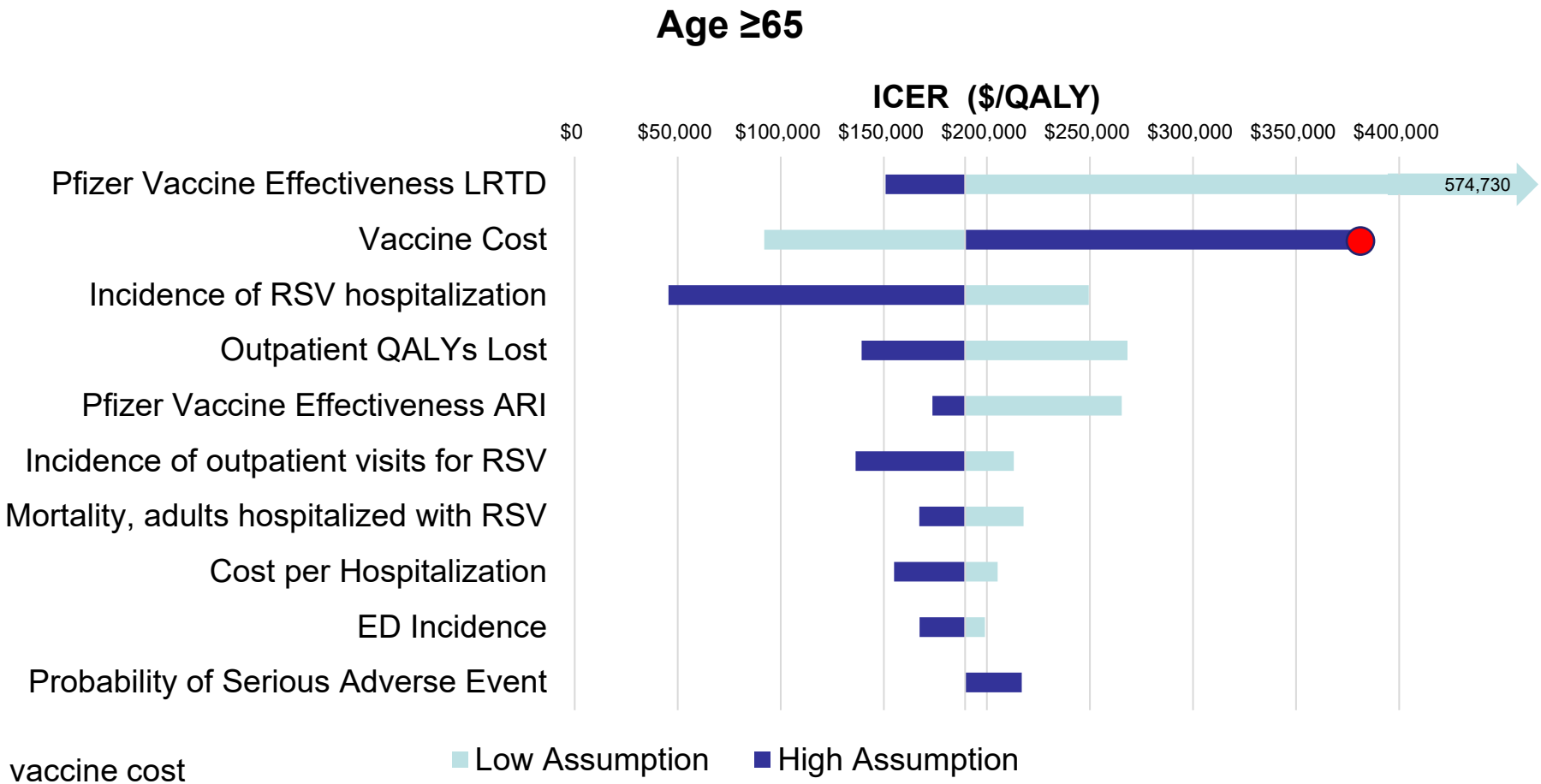
- Tornado Diagrams
  - one parameter varied at a time
- Age and Vaccine Cost
- Higher Incidence / Lower PCR Sensitivity

Sensitivity analyses, GSK Tornado Diagram



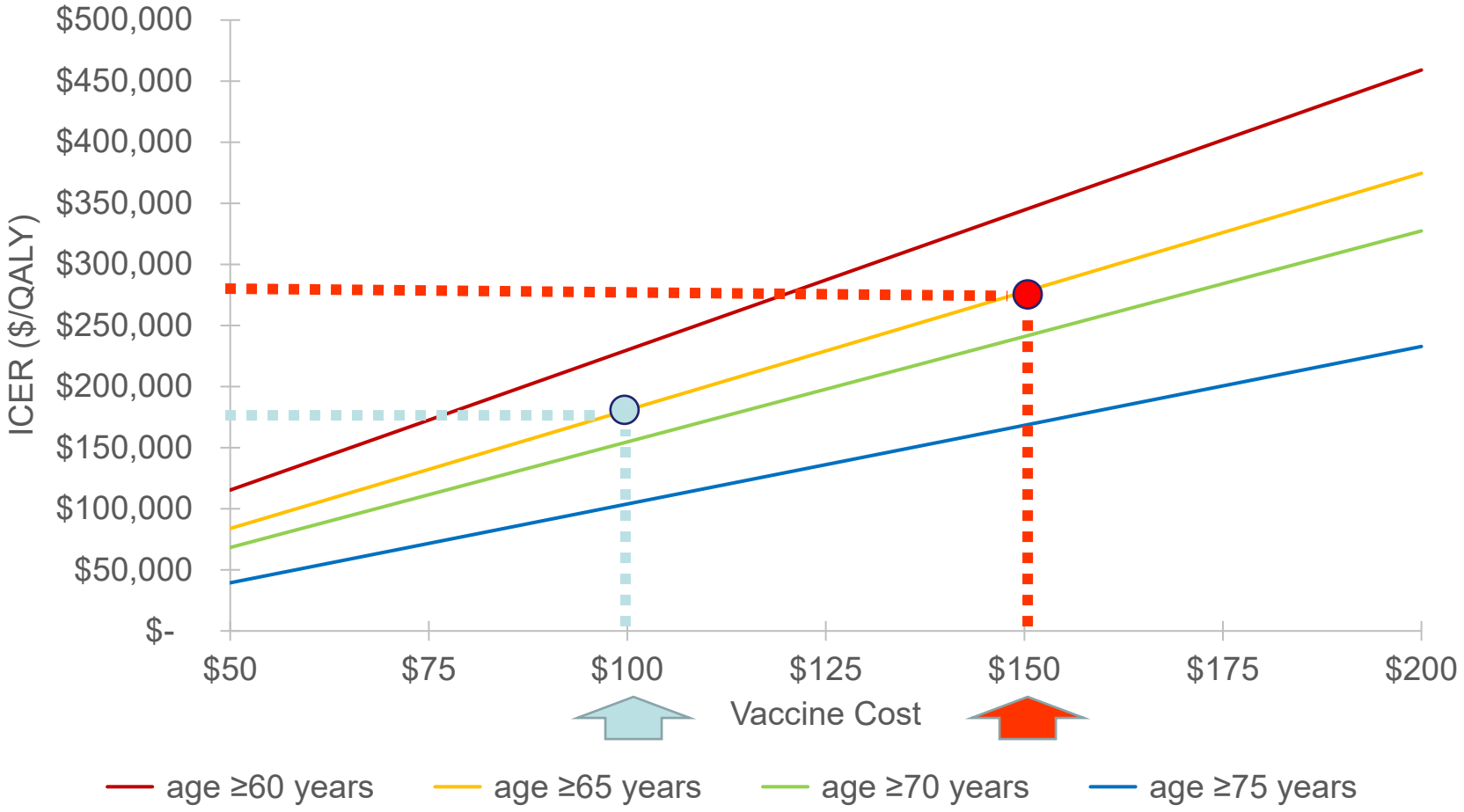
$100 vaccine cost
One Year Time Horizon
Age-based vaccination recommendation: ≥65 years

Sensitivity analyses, Pfizer Tornado Diagram



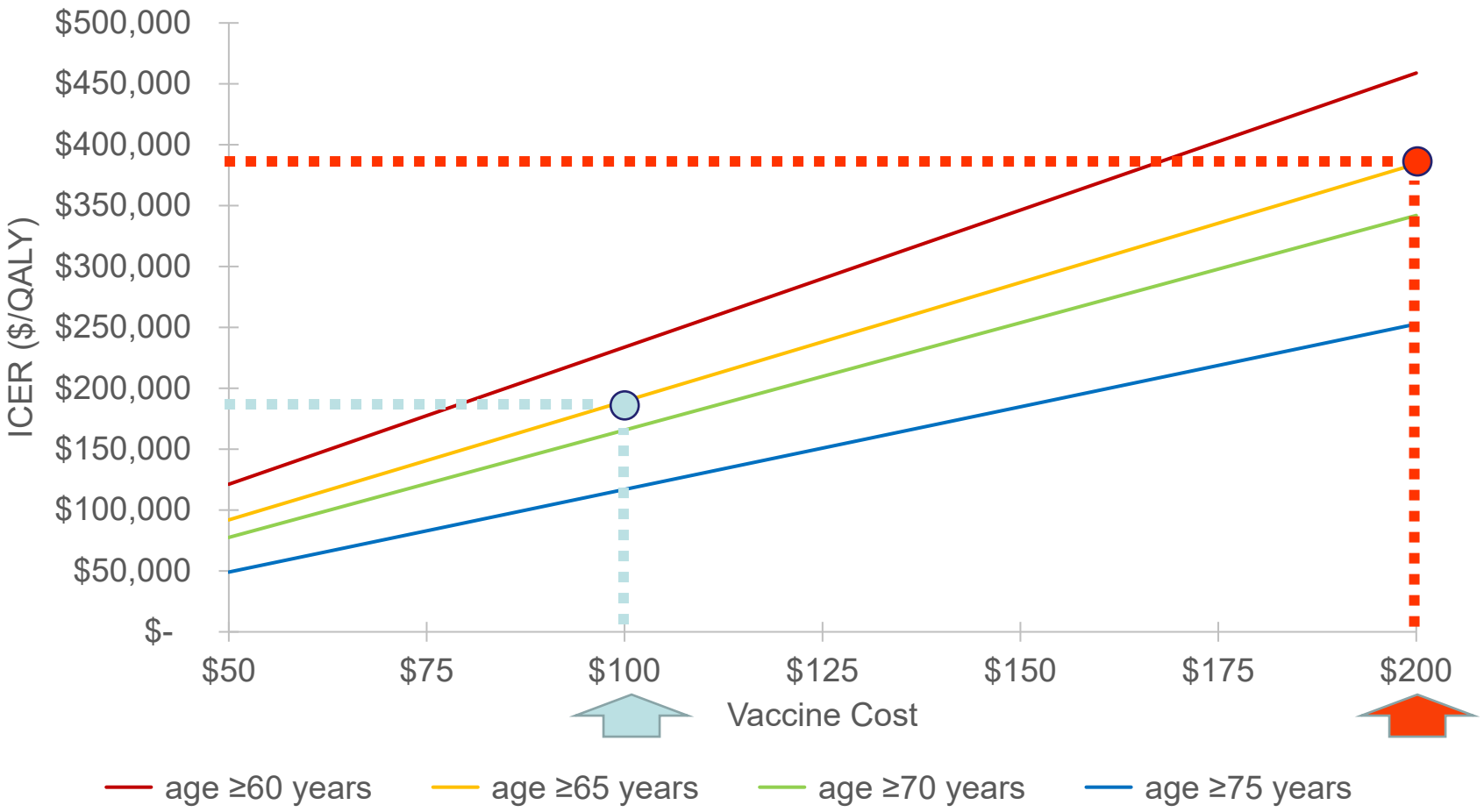
$100 vaccine cost
One Year Time Horizon
Age-based vaccination recommendation: ≥65 years
* At low Pfizer vaccine efficacy, the ICER rises to $574,730/QALY

Sensitivity analysis: Vaccine Cost, GSK



One Year Time Horizon

Sensitivity analysis: Vaccine Cost, Pfizer



One Year Time Horizon

Sensitivity analyses, Higher Incidence

- Higher incidence in the next 2 slides assumes that RT-PCR test sensitivity is lower than 95% and that additional RSV testing modalities would detect more cases at every level of care[1,2]

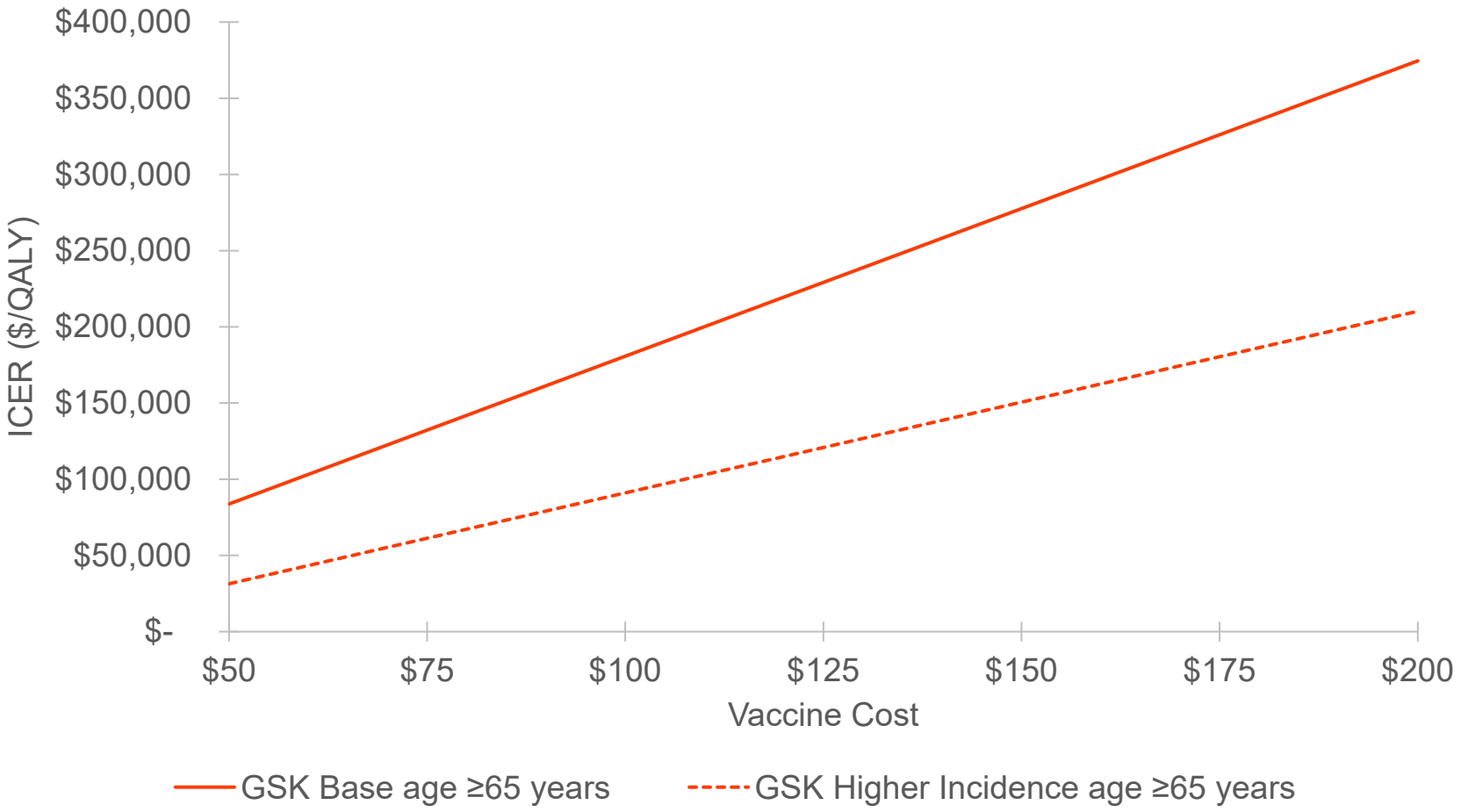
[1] For incidence of hospitalization (RSV-NET), in lieu of adjusting observed incidence for RT-PCR sensitivity of 95%, a 1.4x multiplier is implemented based on Zhang et al. 2016 .

Zhang Y, et al. Serology Enhances Molecular Diagnosis of Respiratory Virus Infections Other than Influenza in Children and Adults Hospitalized with Community-Acquired Pneumonia. J Clin Microbiol. 2016 Dec 28;55(1):79-89. doi: 10.1128/JCM.01701-16. PMID: 27795341; PMCID: PMC5228265.

[2] For incidence of outpatient and ED visits (McLaughlin et al. 2022), this applies the authors' multiplier of 1.5x to the lower (base case) incidence estimates.

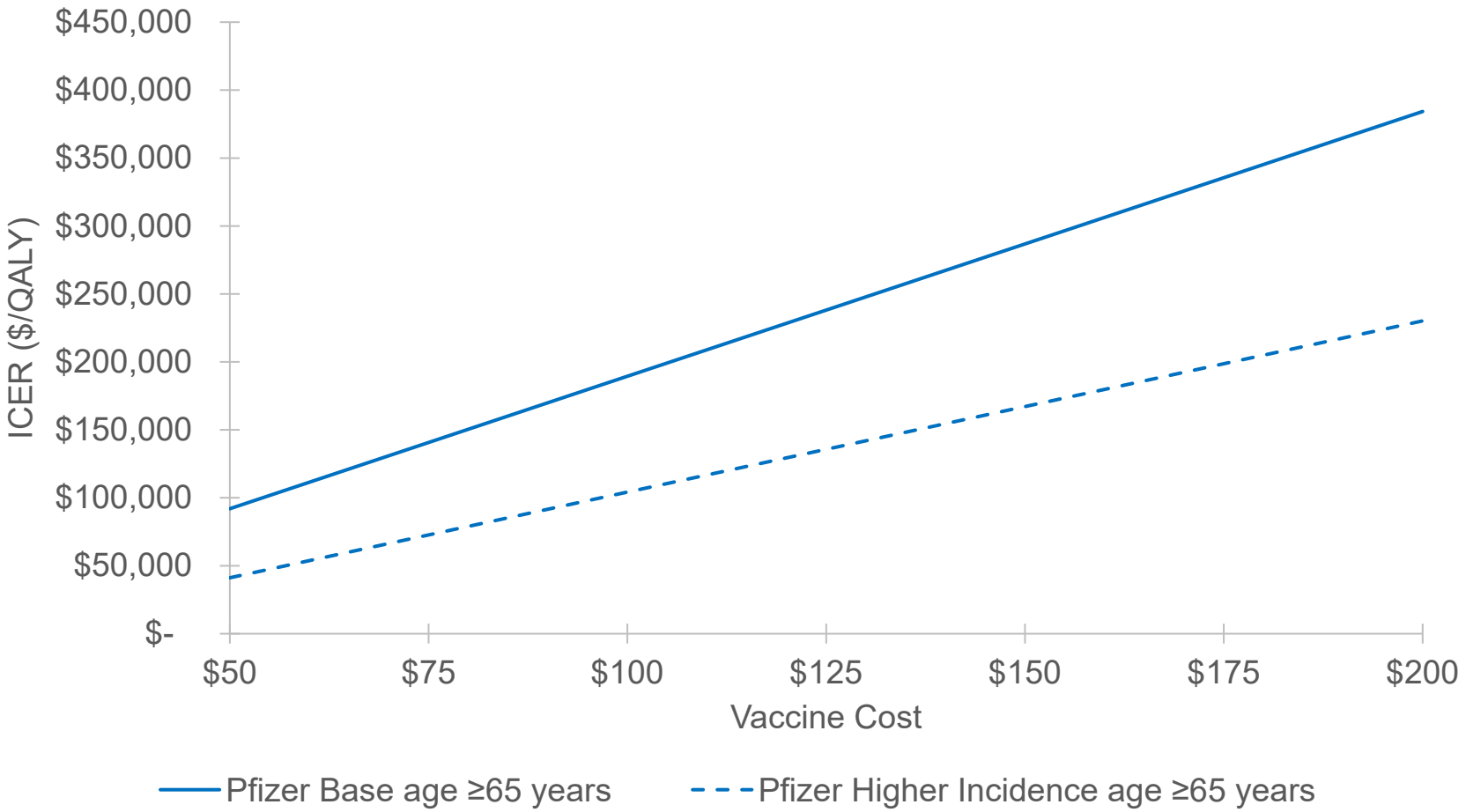
McLaughlin JM, et al. Rates of Medically Attended RSV Among US Adults: A Systematic Review and Meta-analysis. Open Forum Infect Dis. 2022 Jun 17;9(7):ofac300. doi: 10.1093/ofid/ofac300. PMID: 35873302; PMCID: PMC9301578.

Sensitivity analyses, GSK Higher Incidence



Age-based vaccination recommendation: ≥65 years
One Year Time Horizon

Sensitivity analyses, Pfizer Higher Incidence



Age-based vaccination recommendation: ≥65 years
One Year Time Horizon

Limitations

- Model Structure
  - No risk groups
  - No dynamic transmission. No impact of the vaccine on transmission and indirect effects
  - No direct medical costs post-discharge (e.g. rehab)
- Uncertain inputs
  - Vaccine cost
  - RSV Incidence
  - Long-term efficacy

Summary

- Results vary based on:
  - Vaccine Cost
    - ICER: ~80,000 - 385,000 $/QALY
  - Vaccine Efficacy
    - ICER: ~150,000 - 575,000 $/QALY
  - Ages Vaccinated
    - ICER: ~100,000 - 230,000 $/QALY
  - Incidence of Hospitalization
    - ICER: ~30,000 - 250,000 $/QALY

Thank You

- Please send comments to:
- dwhutton@umich.edu