

Cost-effectiveness of live attenuated chikungunya vaccine among adults living in US territories

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Conflicts of Interest Statement

- **Authors have no known conflict of interests**
- **The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.**

Outline

- **Research question**
- **Methods**
- **Results**
- **Sensitivity analyses**
- **Limitations**
- **Summary**

Research Question

- **What is the cost-effectiveness of using a single dose of the live attenuated chikungunya vaccine among the population aged ≥ 18 years in US territories* that previously experienced an outbreak of chikungunya?**

*American Samoa, Puerto Rico (PR), and US Virgin Islands (USVI)

Methods

Economic Model

- **Population-based model**
 - Entire population of three US territories in model
- **Time step: 1 year**
- **Analytic time horizon: 30 years starting in 2024**
- **Discount rate: 3%**
- **Perspectives: societal and healthcare payer**
- **One chikungunya outbreak occurring in 2034**

Intervention

- Use of live-attenuated chikungunya vaccine

	Strategy 1: Routine Vaccination	Strategy 2: Outbreak Vaccination
Annual Vaccination	Yes	No
Coverage rate ¹	20%	--
Outbreak campaign in 2034	Yes	Yes
Coverage rate ²	70% ³	70%

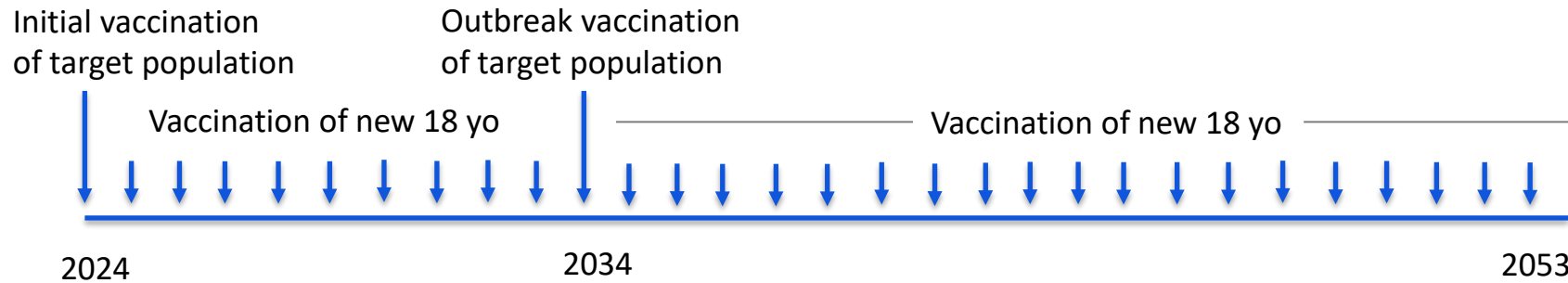
1 Routine coverage rate range based on annual influenza vaccine uptake in Puerto Rico (CDC data)

2 Outbreak coverage rate range based on Covid-19 vaccine uptake in Puerto Rico (CDC data)

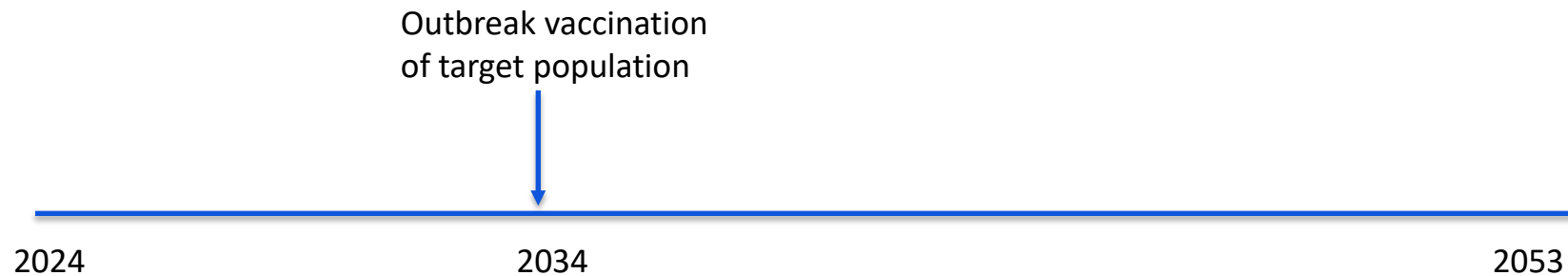
3 Total coverage rate for outbreak year considers routine vaccinations from all prior years and vaccinations during outbreak. Individuals are vaccinated only once.

Strategy Comparison

Routine strategy



Outbreak strategy



Outcomes

- **Estimated population-level health outcomes**
 - Symptomatic cases
 - Hospitalizations
 - Chronic joint pain cases
 - Deaths
 - Quality-adjusted life-years (QALYs) lost
- **Estimated economic outcomes**
 - Societal costs – vaccination, medical, and lost productivity costs
 - Healthcare payer costs – vaccination and medical costs

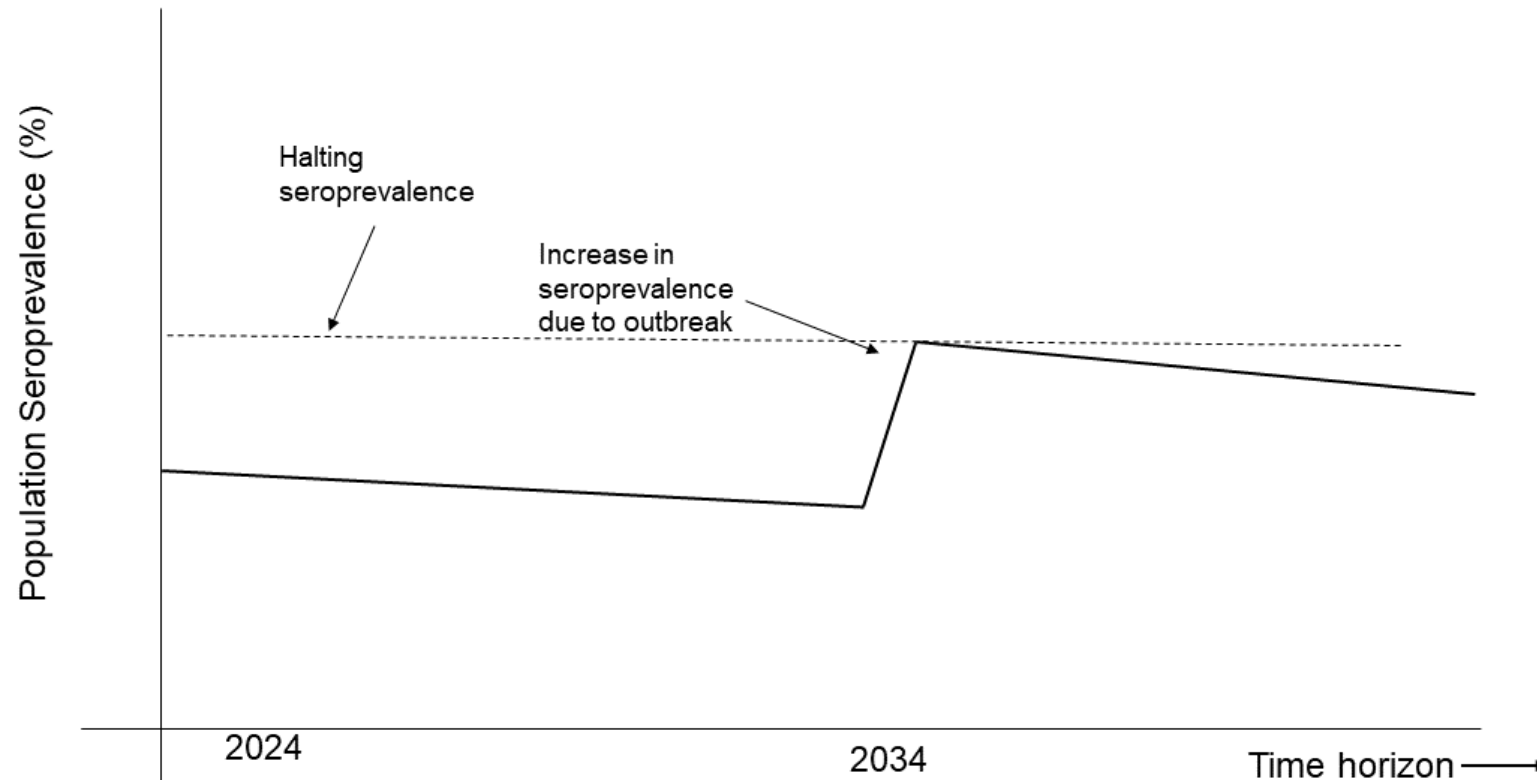
Analysis Approach

- **Calculated incremental cost-effectiveness ratios comparing vaccination to no vaccination**
 - Measured as \$ per each outcome averted (or QALYs gained)
- **Monte Carlo simulation with 1,000 replications to estimate results with 95% CIs using @Risk software**
- **Conducted sensitivity analyses (univariate and scenario)**

Model Assumptions

Lifelong Immunity and Halting Seroprevalence

- Chikungunya virus infection confers lifetime immunity
- Outbreak would stop once certain level of population is infected (halting seroprevalence)



Model Inputs

Infection Inputs

Variable	Value	Range		Source
		Low	High	
Baseline seroprevalence*	31%	18%	42%	USVI ¹ and PR ² data
% symptomatic among infected	72%	53%	97%	USVI data ¹

USVI – US Virgin Islands; PR – Puerto Rico

* Level of population immunity from prior outbreak in adult population. By 2024, baseline seroprevalence has waned to 28% in population.

1. Hennessey MJ, et al. Amer J Trop Med Hyg, 2018; 99:1321-1321.
2. Adams LE, et al. PLOS NTD. 2022; 16:e0010416-e0010416.

Health Outcome Inputs

Variable	Value	Range		Source
		Low	High	
% care-seeking	43%	30%	82%	USVI data ¹
% hospitalized*	10%	5%	15%	USVI data ¹
% with chronic joint pain ⁺	35%	19%	61%	Metanalysis ²
% death [^]	1%	0.1%	3%	PR data ³

USVI – US Virgin Islands, PR – Puerto Rico

* of those seeking care

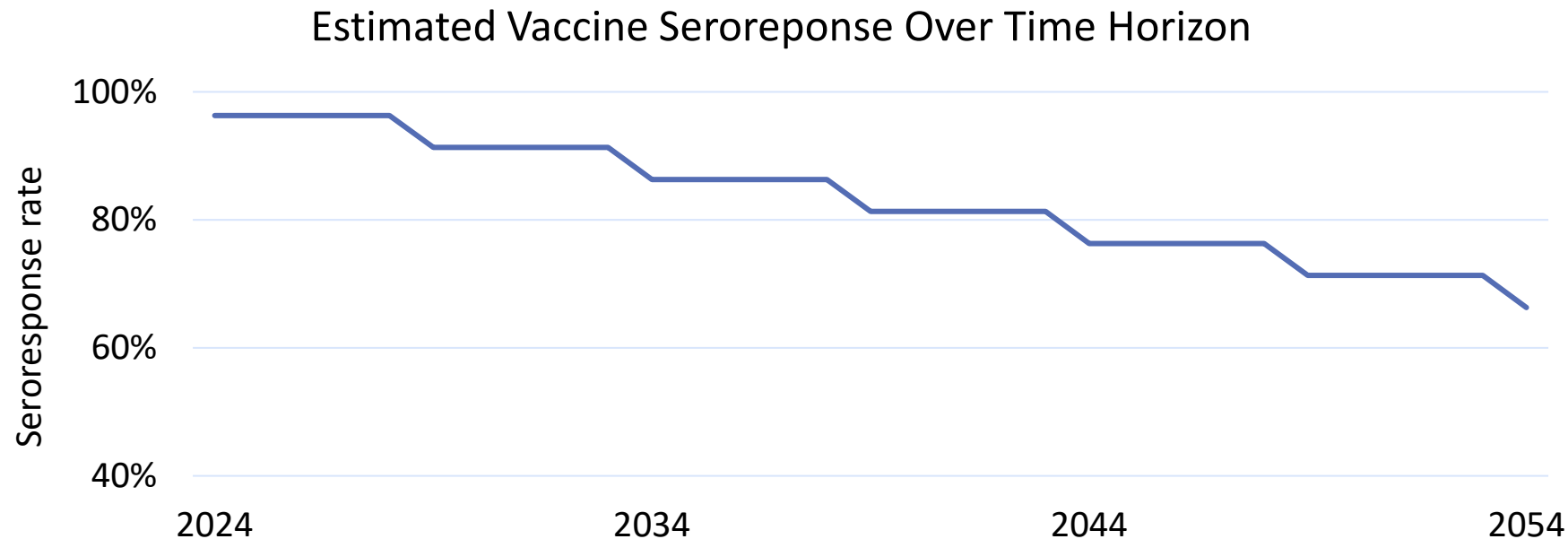
⁺ 6 months after infection

[^] of those hospitalized

- 1 Hennessey MJ, et al. Amer J Trop Med Hyg, 2018; 99:1321-1321.;
Hennessey MJ, et al. Centers for Disease Control and Prevention, 2015.
- 2 Lindsey NP. ACIP presentation. 2023
- 3 Sharp TM, et al. J Infect Dis. 2016; 214: S475-S481

Vaccine Seroresponse

- Vaccine seroresponse rate of 96.3% (clinical trial data)¹
- Decay in vaccine seroresponse rate of 5 percentage points every 5 years based on other live attenuated or chimeric vaccines²



1. Schneider M, et al. Lancet. 2023; 401:2138-2147.

2. Lindsey NP, et al. J Travel Medicine. 2018; 25:tay108; Desai KL, et al. Vaccine. 2012; 30:2510-2515.

QALY Inputs

Variable	Time	Weight (range)	QALYs Lost (range)	Source
Non-hospitalized case*^	7 days	0.63 (0.19-0.91)	0.01 (0.002-0.016)	Dengue ¹
Hospitalized case*	14 days	0.56 (0.19-0.91)	0.02 (0.004-0.031)	Dengue ¹
Chronic joint pain case	1 year	0.76 (0.65-0.90)	0.24 (0.10-0.35)	Chikungunya and rheumatoid arthritis ^{2,3}

QALY – quality-adjusted life-year; QALY losses due to death are included and include loss beyond time horizon of model

*Weights for acute disease based on dengue; no weights available for chikungunya

^All symptomatic cases had QALY losses regardless of care-seeking behavior

1 Zeng W, et al. Am J Trop Med Hyg. 2018; 99:1458-1465.

2 Couzigou B, et al. Am J Trop Med Hyg. 2018; 99:182-190.

3 Sorensen J, et al. Value Health. 2012; 15:334-339

Sensitivity Analyses Methods

Sensitivity Analyses

- **Univariate (one-way) analysis**

- Varied one parameter at a time and calculated mean \$/QALY gained using low (1%) and high (99%) values of input distributions

- **Scenario analyses**

- Altered year of outbreak to 2029 or 2039 (base: 2034)
- Altered halting seroprevalence to 30%¹ or 80%² (base: 40%)
- Altered vaccination coverage
 - Routine 10% or 30% (base: 20%)
 - Outbreak 50% or 85% (base: 70%)

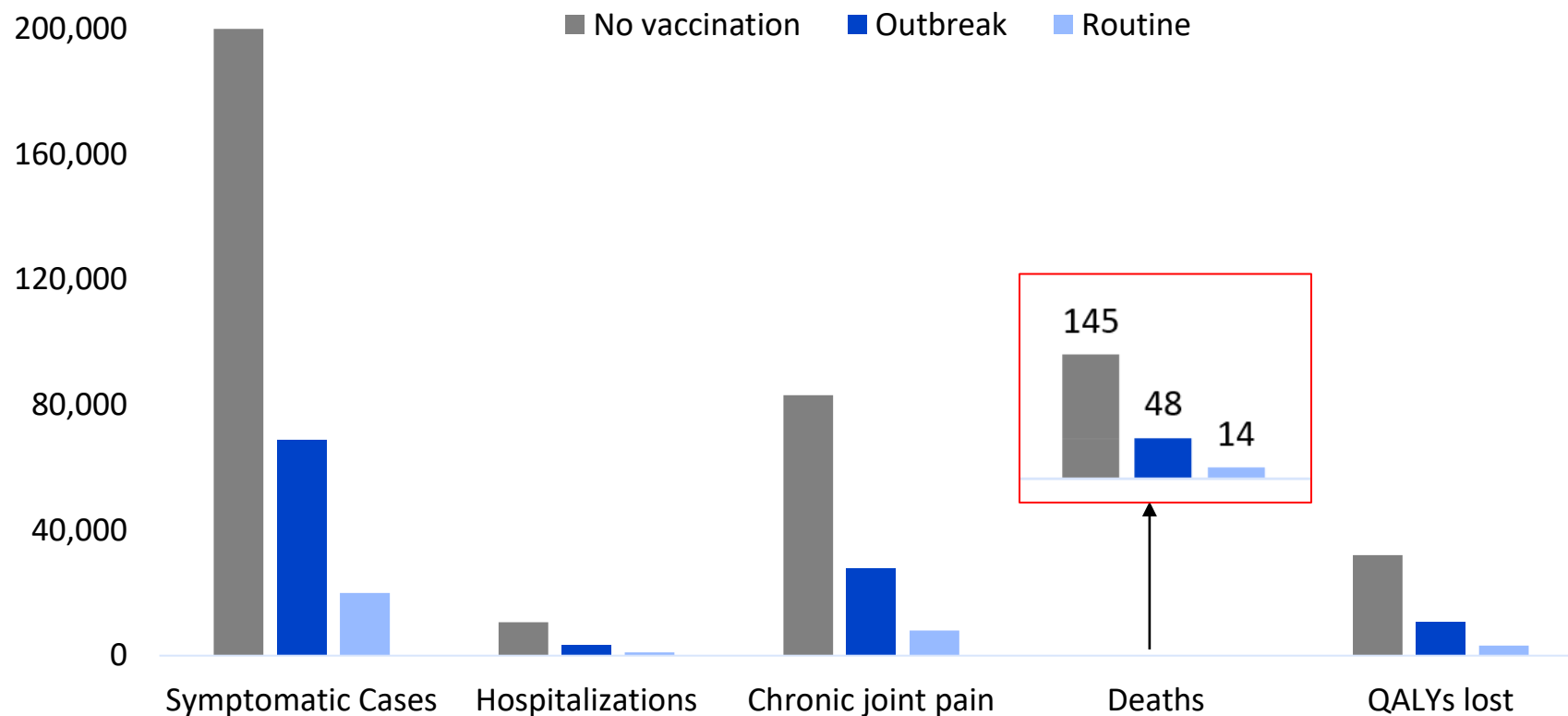
1 Hennessey MJ, et al. Amer J Trop Med Hyg, 2018; 99:1321-1321 & Adams LE, et al. PLOS NTD. 2022; 16:e0010416-e0010416

2 Jamaican MoH. JHLSIII, 2018

Results

Health Outcomes

- Outbreak strategy averts 67% of health outcomes
- Routine strategy averts 90% of health outcomes



Vaccination Doses and Costs*

- **More doses delivered in routine strategy during 30-year time horizon than outbreak strategy**
- **Base scenario vaccination costs**
 - **Routine strategy: \$436 million**
 - **Outbreak strategy: \$356 million**

*Vaccination costs include vaccines, administration, and adverse event costs
All costs converted to 2023 \$US

Total Costs

Outcome	Strategy	Total costs, No vaccine (millions)	Total costs, Vaccine (millions)	Difference
Societal Costs*	Routine	\$566	\$496	-12%
	Outbreak	\$566	\$547	-3%
Healthcare Payer Costs^	Routine	\$269	\$465	73%
	Outbreak	\$269	\$449	67%

All costs converted to 2023 \$US

* Societal costs include vaccination costs, direct medical costs, and indirect costs due to lost productivity.

^ Healthcare payer costs include vaccination costs and direct medical costs.

Cost-effectiveness, Societal Perspective

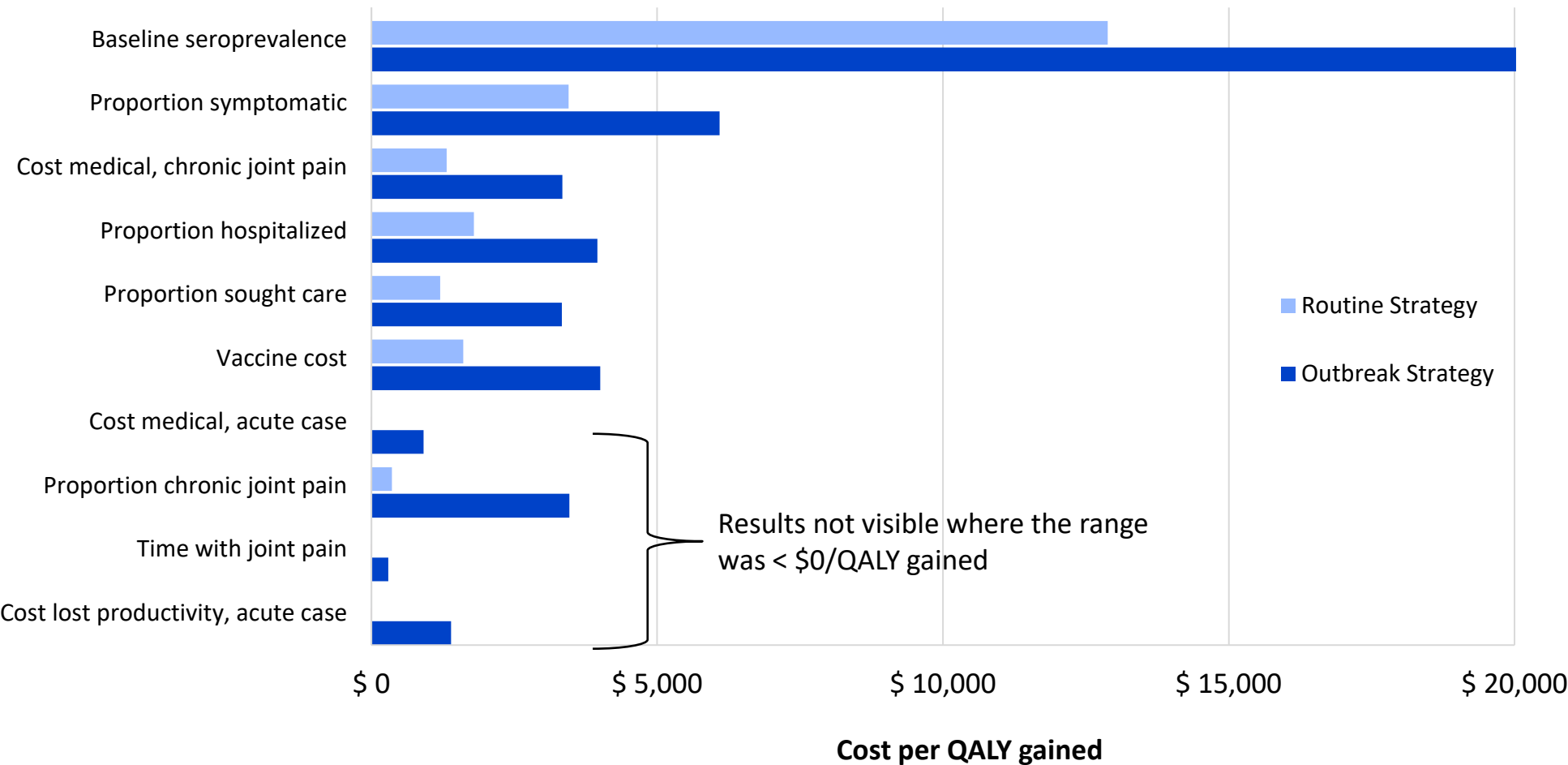
	Symptomatic Case	Hospitalization	Chronic joint pain case	Death	QALY gained
Mean cost per outcome averted [95% CI]					
Routine Strategy	Cost savings	Cost savings	Cost savings	Cost savings	Cost savings
Outbreak Strategy	Cost savings	\$2,315 [\$1K, \$4K]	\$5 [Cost savings, \$200]	\$373,054 [\$173K, \$573K]	\$59 [Cost savings, \$1K]

Sensitivity Analyses Results*

*Presented from societal perspective

Univariate Sensitivity Analysis, Routine Strategy

Top 10 influential inputs, ranked by impact to mean \$/QALY gained



Sensitivity Analysis for Outbreak Timing*

	Routine strategy	Outbreak strategy
	Mean \$/QALY gained [95% CI]	
Outbreak occurs in 2029	Cost savings	\$3,829 [\$3K, \$4.6K]
Outbreak occurs in 2039	Cost savings	Cost savings

*Base scenario had outbreak occurring in 2034

Scenario Analysis Varying Halting Seroprevalence and Vaccination Coverage*

- **30% halting seroprevalence: all scenarios have net positive costs**
 - **Low vaccination** has the lowest cost per QALY gained
- **40% halting seroprevalence (base value): high vaccination has net costs, base and low vaccination result in cost savings**
 - **Low vaccination** has the lowest cost per QALY gained
- **80% halting seroprevalence: all scenarios result in cost savings**
 - **High vaccination** has lowest cost per QALY gained

*Vaccination Coverage Rates:

Base vaccination= 20% routine, 70% outbreak; Low vaccination= 10% routine, 50% outbreak; High vaccination= 30% routine, 85% outbreak

Limitations and Summary

Limitations

- 1. No efficacy or effectiveness data available for current vaccine; data planned to be generated in post-licensure studies**
- 2. Limited evidence on outbreak frequency (i.e., when and how many) in same geographical locations**
- 3. QALY health utility weights mostly from dengue as proxy since no weights determined for acute chikungunya**

Summary

- **Chikungunya vaccine use in US territories would avert 67-90% of cases and associated health outcomes versus no vaccination**
- **Cost of intervention would range from \$356 to \$436 million depending on strategy used**
- **Routine strategy had cost savings for each outcome while outbreak strategy had mostly net positive costs in base scenario**
- **Results most affected by baseline and halting seroprevalence**

For more information, contact CDC
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