Economics of vaccinating immunocompromised 19–49-years-old adults against herpes zoster in the US

A SUMMARY REPORT OF CDC & GSK MODELS

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Presentation: September 29, 2021; ACIP Zoster Vaccines Session

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Conflict of interest

- CDC model: **Andrew Leidner**, Kai Hong, Tara Anderson, Angela Guo, Jamison Pike, Lisa Prosser, Ismael R. Ortega-Sanchez, Kathleen Dooling
  - No conflicts of interest

- GSK model: Elizabeth La, Desmond Curran, Sara Poston et al., [see complete author list and affiliations]
  - GSK manufacturers the RZV vaccine *and* RTI Health Solutions

Overview

- **Policy question:** Should adults ≥19 years of age who are or will be immunodeficient or immunosuppressed due to disease or therapy be recommended to receive two doses of RZV for the prevention of herpes zoster and its complications?

Age	19–49 years	≥50 years
General (immunocompetent) population	Not currently under consideration	Recommended
Immunocompromised	Under consideration HSCT | Other patient groups	Under consideration

Economic analysis

Question: Is vaccinating immunocompromised* adults against herpes zoster *cost-effective*?

Comparator: Unvaccinated immunocompromised 19–49-years-old adults

Intervention: Immunization of immunocompromised 19–49-years-old adults

Base-case scenario: What is the incremental *cost-effectiveness* of vaccinating HSCT recipients who are 19–49-years-old using RZV relative to No vaccine?

* Immunocompromised = immunodeficient or immunosuppressed due to disease and/or therapy

IC populations: Base-case and Scenarios

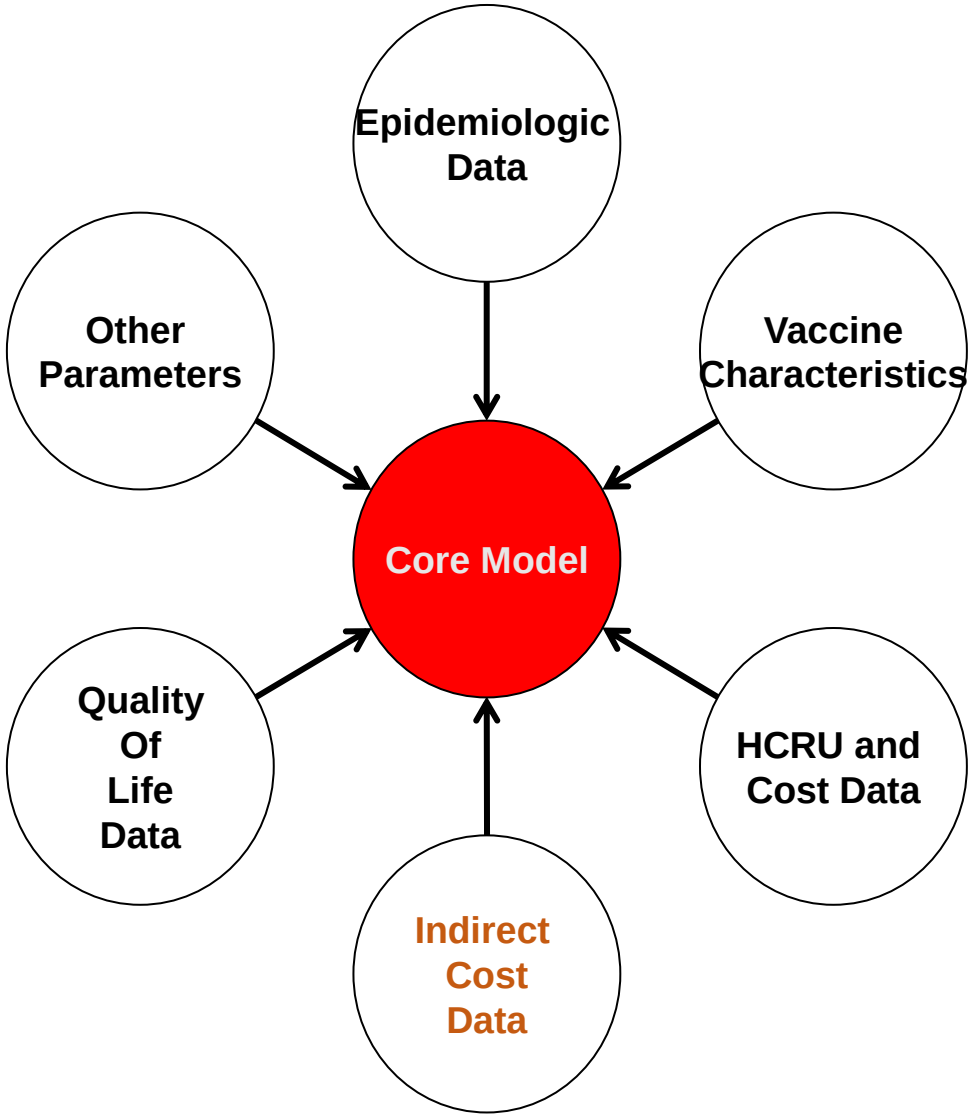
CDC	GSK
BASE-CASE: Hematopoietic stem cell transplant (HSCT) recipients	

People living with Human immunodeficiency virus (HIV) infection	
Multiple Myeloma	Renal or other solid organ transplant
Non-Hodgkin Lymphoma	Hodgkin Lymphoma
Hematologic malignancies	Breast cancer
Autoimmune and other inflammatory	

Design

- Static analytical decision-making models
- Probabilistic simulation and sensitivity analyses
- Hypothetical population
  - Base-case: cohort of 19-49 yo HSCT recipients
- Time Frame: time of vaccination with 1st and 2nd dose of RZV
- Analytic Horizon: Age-specific Life Expectancy or 30 years
- Discount rate: 3% (0%-6%)
- Healthcare & Societal perspectives

Inputs and main outcomes



Prevention of:

- Uncomplicated HZ cases
- HZ with PHN
- Inpatient care of HZ
- HZ-associated deaths

QALYs saved
$/Case saved
$/QALY saved

NNV avert a:

- HZ Case, PHN case
- Hospitalization
- Death

Cost-saving vs Cost-Effective

Cost of intervention: Cost of vaccination program

Savings from intervention = Changes in cost of illness (*without* vaccination program costs)

$$\textit{Net cost}_{vacc} = \text{Cost of intervention} - \text{Savings from intervention}$$

Cost-saving: Cost of intervention **<** Savings from intervention

All cost-saving interventions are also cost-effective, but not all cost-effective interventions are cost-savings, not necessarily.

Economic evaluation:

Incremental cost-effectiveness ratio (*ICER*) **:**

$$ICER = \frac{C_{vacc} - TC_{saved}}{\sum_{t=0}^{T} \frac{(HO_{unvacc} - HO_{vacc})}{(1+r)^t}}$$

ICE < 0 Cost-savings (cost-effective)

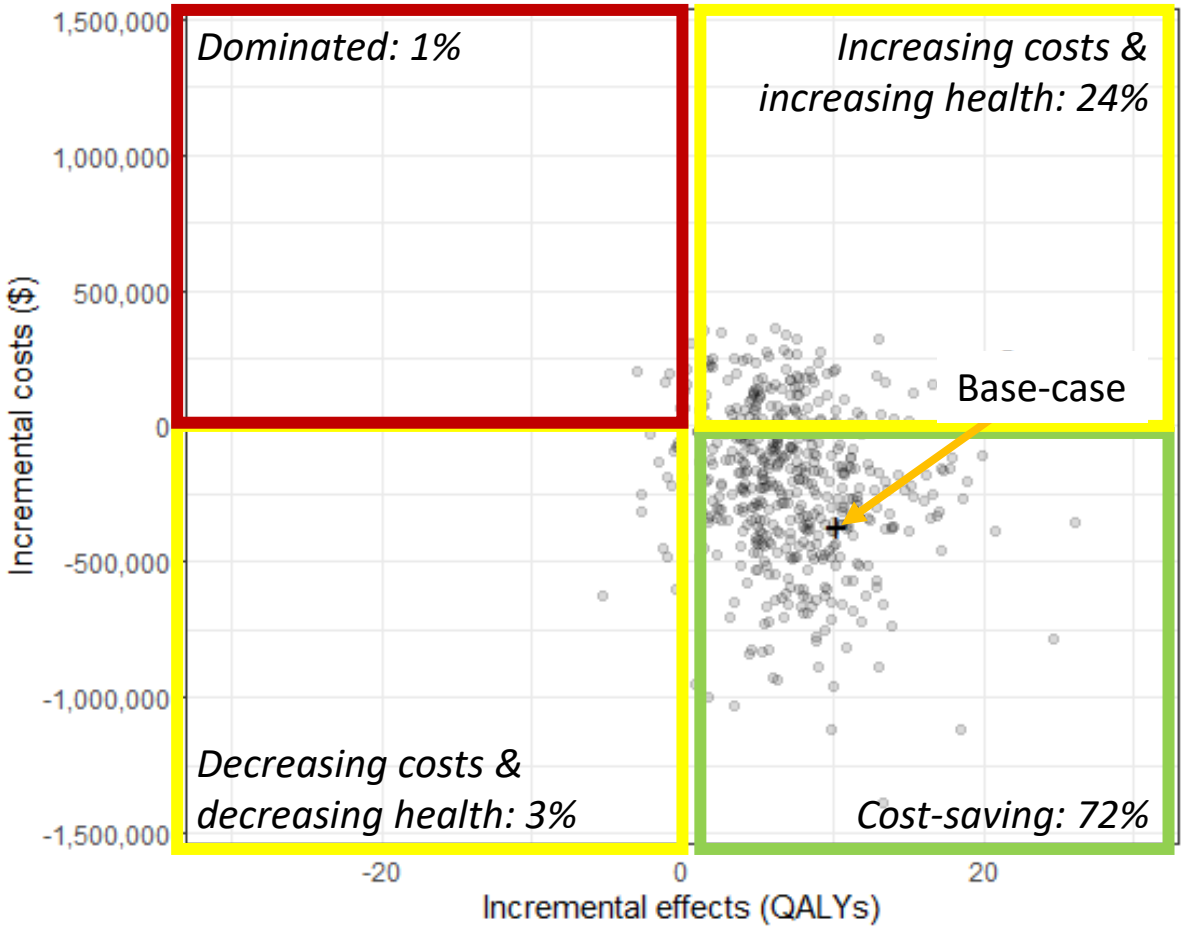
ICE > 0 Costly Cost-effective**?**

Where:

- ***Cvacc*** **=** Cost of intervention (vaccination program costs)
- ***TCsaved*** **=** Total savings (difference in disease costs under No vaccination vs. RZV vaccination)
- ***HOvacc*** **=** Health outcome of vaccination (ex., HZ cases, QALYs)
- ***HOunvacc*** **=** Health outcome of No vaccination (ex., HZ cases, QALYs)
- ***t*** **=** time in years after immunization *(t=0, 1, 2,…, T)*
- ***r*** **=** discount rate (3%)
- ***T*** **=** Analytical horizon (age-specific, in years)

CDC: HSCT, base case estimates & PSA

Summary outcomes	Base-case
$ / QALY gained	Cost-saving
$ / HZ case averted	Cost-saving
$ / hospitalization averted	Cost-saving
$ / death averted	Cost-saving
NNV avert case	10
NNV avert hospitalization	95
NNV avert death	10,608



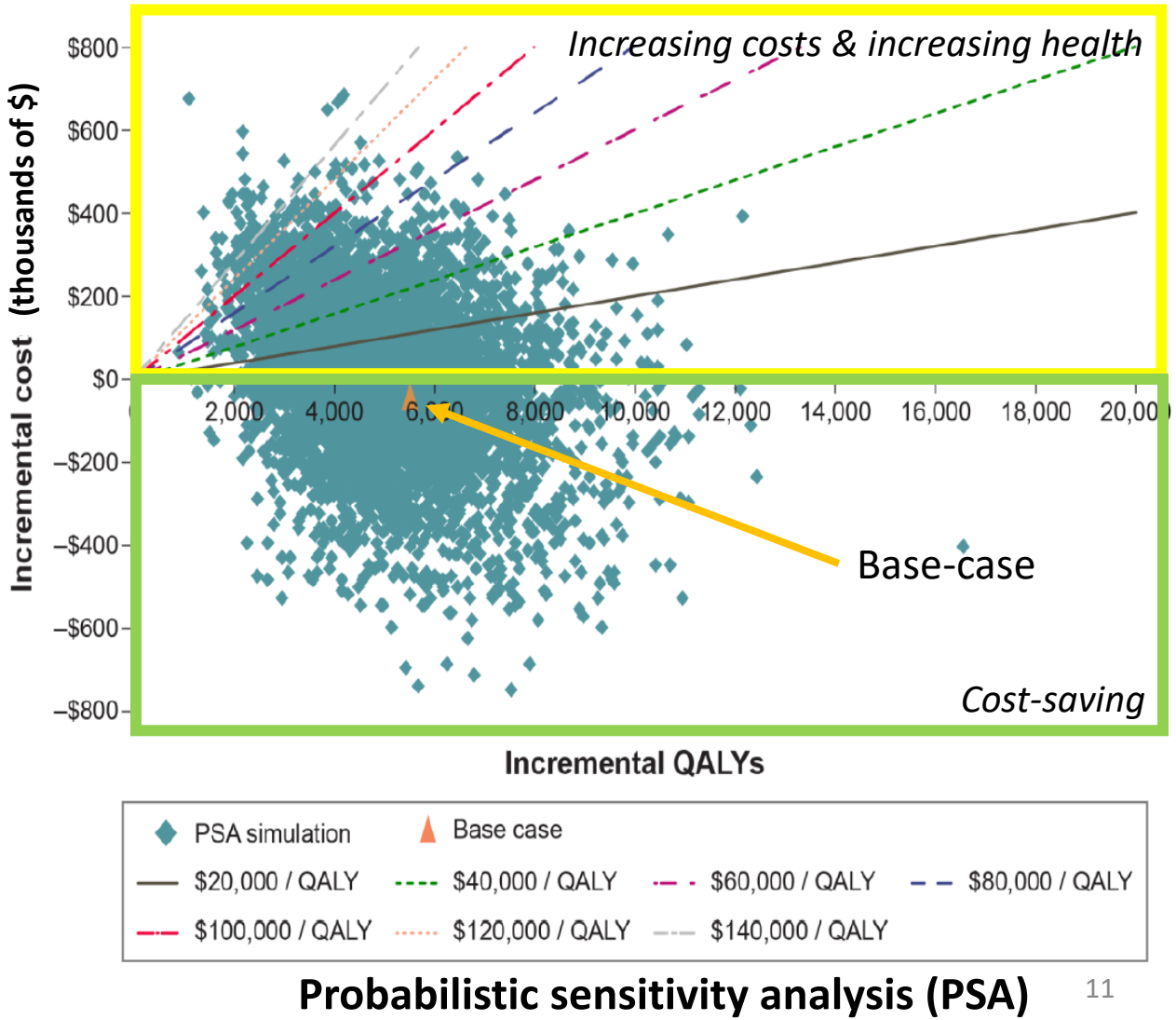
Probabilistic sensitivity analysis (PSA)

GSK: HSCT, base case estimates & PSA

Summary outcomes	Base-Case
$ / QALY gained	Cost-saving
$ / HZ case averted	Cost-saving
$ / hospitalization averted	n/r
$ / death averted*	n/r
NNV avert case	8.6
NNV avert PHN	46.6
NNV avert death*	n/r

n/r = not reported

* Difference in number of HZ deaths between "No Vaccination" and "RZV vaccination" was reported to be zero by GSK model



Probabilistic sensitivity analysis (PSA)

GSK and CDC models comparison (I): analytical approach and inputs

- Age groups considered
  - CDC: Three groups: 19-29yos, 30-39yos and at 40-49yos
  - GSK: 19-49yos (0ne group only) starting of age 35yrs
- Annual HZ incidence in HSCT
  - CDC: 40.2 (range 35.6 to 45.12) per 1000 PY
  - GSK: 60 (range 40 to 80) per 1000 PY
- Probability of PHN
  - CDC: Base case 9.1% (range 6% to 41%)
  - GSK: Base case 12.9% (range 8.5% to 17.3%)
- Antiviral prophylaxis following HSCT
  - CDC: Prophylaxis period 6mos, SA 1mo to 2yrs
  - GSK: No specific/not explicit
- Vaccination coverage
  - CDC: Dose-specific 1st dose <93% & 2nd dose <86%
  - GSK: 1st dose & 2nd dose 100% (Base-case), SA 76%-100%
- Utilities-Background
  - CDC: age specific and reduction for IC to 86%
  - GSK: adjusted for baseline quality of life among IC
- Duration/transition to IC status
  - CDC: 2yrs for HSCT
  - GSK: 5yrs for HSCT (range 2 to 30yrs scenario-specific)
- Initial VE & waning of VE in time
  - CDC Initial VE per dose: 1st 39%, 2nd 68% in 21months follow-up
    Years until no VE 1st dose 11yrs, 2nd 20yrs.
  - GSK Initial VE per dose: 1st 58%, 2nd 72.5%,
    Annual VE waning per dose 1st 18.2%, 2nd 9.1% during IC status
- Unitary cost of HZ outcomes
  - CDC: **Direct cost**: non PHN, non inpatient HZ episode ($1,549), with PHN ($4,906), as inpatient non PHN ($37,852)
  - GSK: **Direct cost**: non PHN HZ episode ($3,578), with PHN ($8,513). **Indirect**: HZ case ($199)

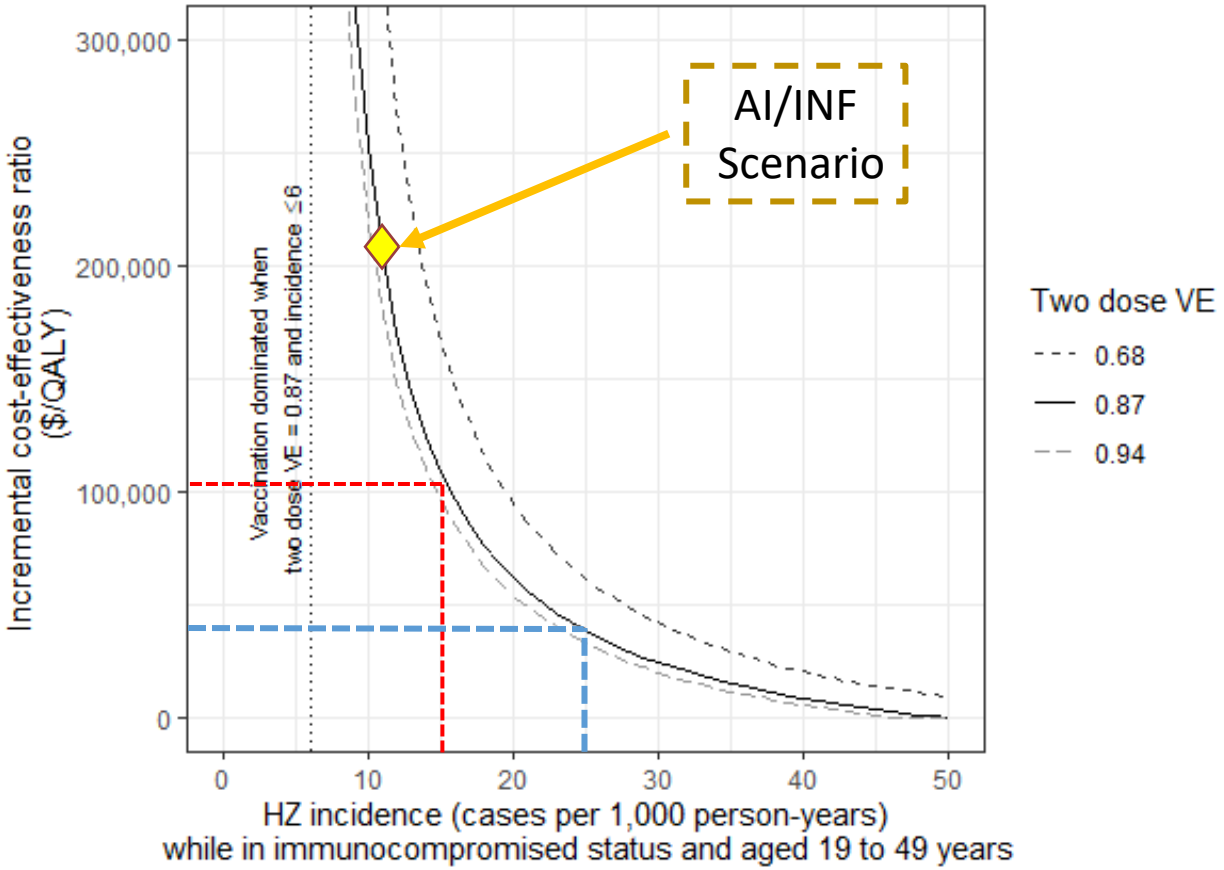
GSK and CDC models comparison (II): base case & scenario results

Scenario	GSK	CDC
HSCT (Base case)	Cost-saving, $140*	Cost-saving
Multiple Myeloma	n/r	Cost-saving
Renal transplant	Cost-saving	n/r
Hematologic malignancy	n/r	$10,000
HIV	$33,000	$79,000
Breast cancer	$68,000	n/r
Hodgkin lymphoma	$96,000	n/r
Non-Hodgkin lymphoma	n/r	$99,000
Autoimmune & inflammatory	150,000 **	$208,000

* Cost-savings **from societal perspective**, $140 from healthcare perspective. n/r = not reported.

** Implicit AI/INF scenario: Assuming starting age 25 years, HZ incidence 10/1000PY *and* duration of IC status 5 years

CDC model: Autoimmune/inflammatory conditions



Scenario inputs

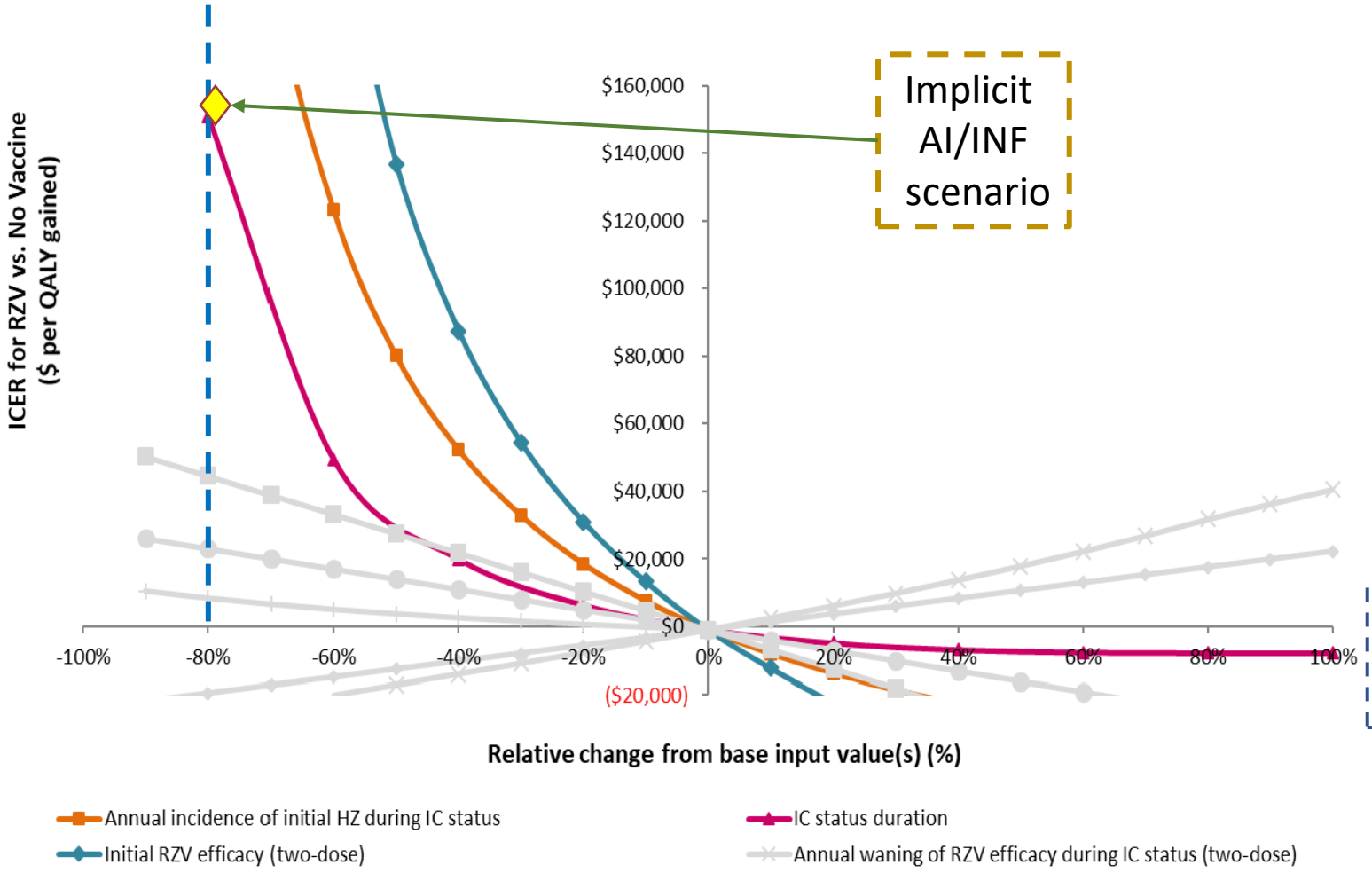
- Lower health care costs
- Higher VE
- Lower incidence
- Lower risks of death

Incidence (cases/1,000 person-years) among 21–50-year-olds with select AI/INF conditions[1]:

- Systemic lupus erythematosus: 15.2—24.6
- Rheumatoid arthritis: 6.6—10.0
- Psoriasis: 3.7—6.4

[1] Yun et al. 2016. "Risk of Herpes Zoster in Autoimmune and Inflammatory Diseases", *Arthritis and Rheumatology* 68(9): 2328-2337.

GSK model: Thresholds in HSCT used to project $/QALY for Autoimmune/inflammatory conditions



Base-case value of annual HZ incidence for HSCT

- 60 (40 - 85) per 1000 PY

HZ incidence in selected AI/INF[1,2] conditions

- 11.5 (3.7-24.6) per 1000 PY

About 80% relative reduction in HZ incidence from base value

1. Chen, S.-Y., et al., *Incidence of herpes zoster in patients with altered immune function.* Infection, 2014. 42(2): p. 325-334
2. Yun et al. 2016. "Risk of Herpes Zoster in Autoimmune and Inflammatory Diseases", *Arthritis and Rheumatology* 68(9): 2328-2337

Discussion

- **Neither model assessed $/QALY in patients ≥50-years-old**
- **Base-case: HSCT patients**
  - Economic value of RZV vaccine appears to be *favorable* (i.e., cost-saving)
    - High(er) HZ incidence and HZ-related health care costs combined with reasonable VE
  - Clinical trial data support VE assumptions
  - Smaller patient population
- **Scenarios: Other patient groups (e.g., HIV, AI/INF)**
  - With lower risk of HZ and healthcare costs, the economic value of RZV vaccination is less favorable relative to HSCT patients
  - Some AI/INF conditions may have *the least favorable* estimates of RZV use, depending on the underlying risk of HZ
  - Larger patient population

End of Summary