

Overview of cost-effectiveness of 9-valent HPV vaccination

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Outline

- Summary of three models of 9vHPV in US
- Impact and cost-effectiveness of 9vHPV vaccination (vs. 4vHPV vaccination)

Three US models of 9vHPV

- **US HPV-ADVISE model** (Brisson et al.)
 - Based on published, 18-type Canadian model
- **Merck model** (Weiss, Pillsbury, Dasbach)
 - Based on published 4vHPV model
- **Simplified model** (Chesson et al.)
 - Based on published 4vHPV model

US HPV-ADVISE based on Canadian HPV-ADVISE model, recalibrated to fit US data. See Drolet et al., *Int J Cancer* 2014; Brisson et al., *Vaccine* 2013; Van de Velde et al., *JNCI* 2012.

Merck model based on Elbasha & Dasbach, *Vaccine* 2010.

Simplified model based on Chesson et al., *Vaccine* 2011.

All three 9vHPV models

- Are dynamic (include “herd effects”)
- Include a wide range of health outcomes
 - Cervical precancers and cancer
 - Other HPV-associated cancers
 - Anal, vaginal, vulvar, penile, oropharyngeal
 - Genital warts
 - Recurrent respiratory papillomatosis (RRP)
 - Exception: HPV-ADVISE model does not include RRP

Selected model characteristics

Model Feature	HPV-ADVISE	MERCK	SIMPLIFIED
Structure	Individual-based	Aggregated	Aggregated
Degree of complexity	Highest	Intermediate	Lowest
Time horizon	70 years	100 years	100 years
Incorporates cervical cancer screening	Yes	Yes	No Screening assumed to occur but not explicitly modeled
Study approach	Examines switching existing 4vHPV program to 9vHPV	Compares 100 years of 9vHPV to 100 years of 4vHPV	Compares 100 years of 9vHPV to 100 years of 4vHPV

Selected model assumptions

Model Feature	HPV-ADVISE	MERCK	SIMPLIFIED
Ages vaccinated	13-17 (both sexes)	9-26 (female) 9-21 (male)	12-26 (female) 12-21 (male)
Vaccine efficacy (9vHPV & 4vHPV)	95%	97%	95%
4vHPV cross-protection against additional types*	In some scenarios	No	In some scenarios
Duration of vaccine protection	Lifetime (20 yrs also examined)	Lifetime (20 yrs also examined)	Lifetime
Vaccine cost per dose*		\$145 4vHPV \$158 9vHPV	

*In scenarios of cross-protection for HPV4, the following efficacies were assumed: 46.2% against HPV 31, 28.7% against HPV 33, 7.8% against HPV 45, 18.4% against HPV 52, and 5.5% against HPV 58 based on review by Malagon et al. Lancet Infect Dis 2012.

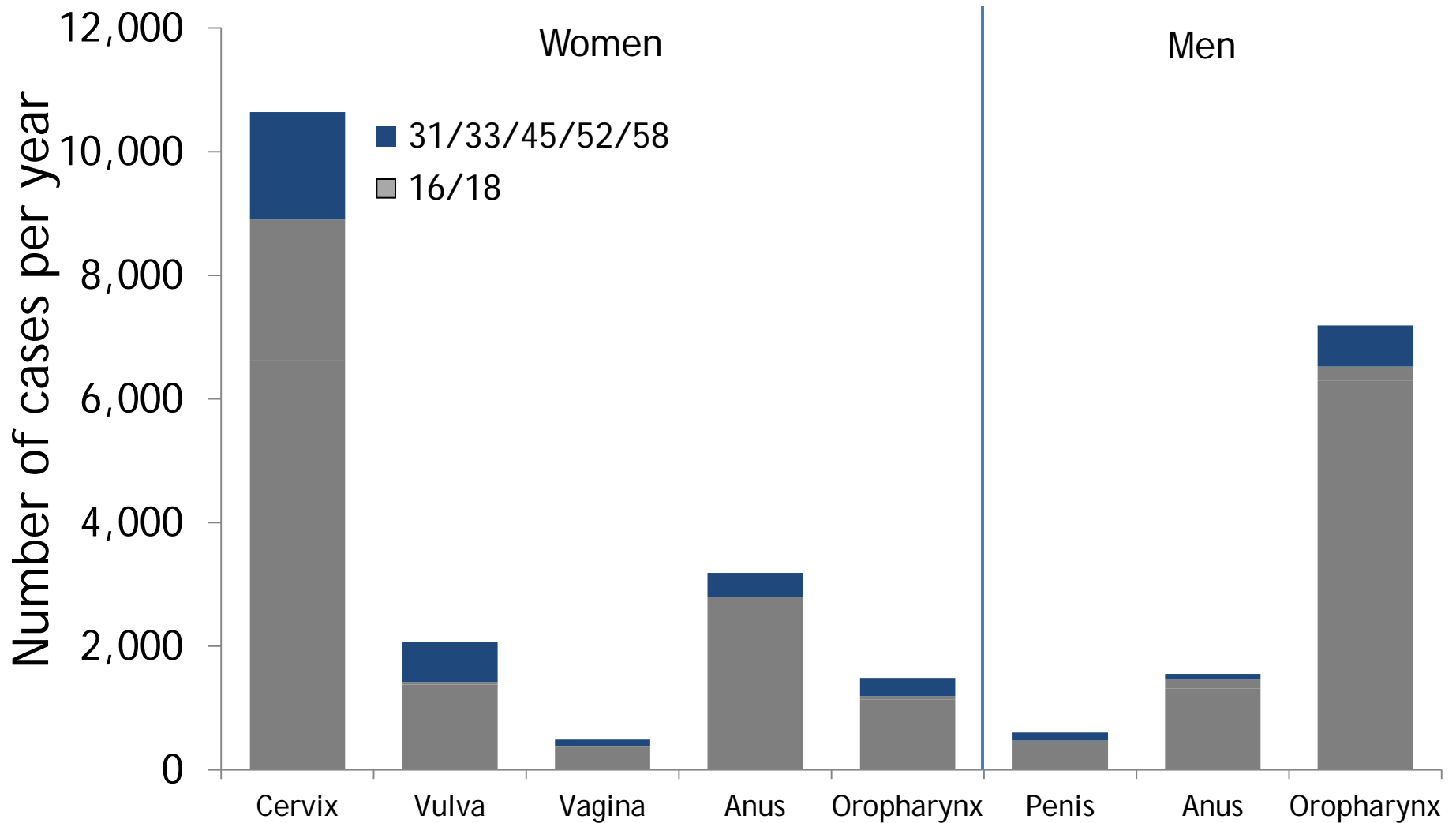
**Includes \$15 per dose administration cost

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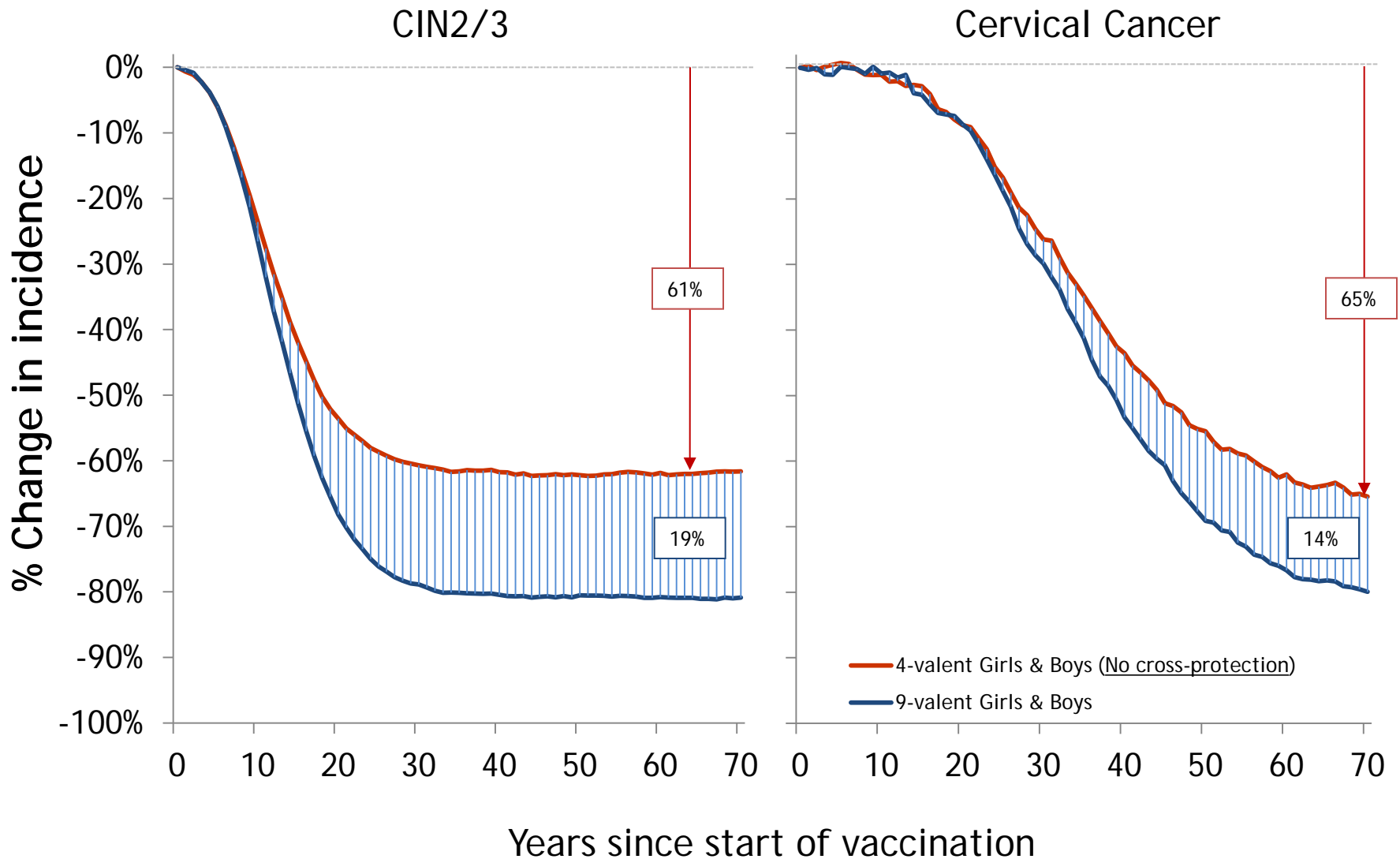
9vHPV

Potential for additional cancer prevention in the U.S.



Effectiveness 4vHPV vs. 9vHPV Girls & Boys

Base case, No cross-protection for 4vHPV

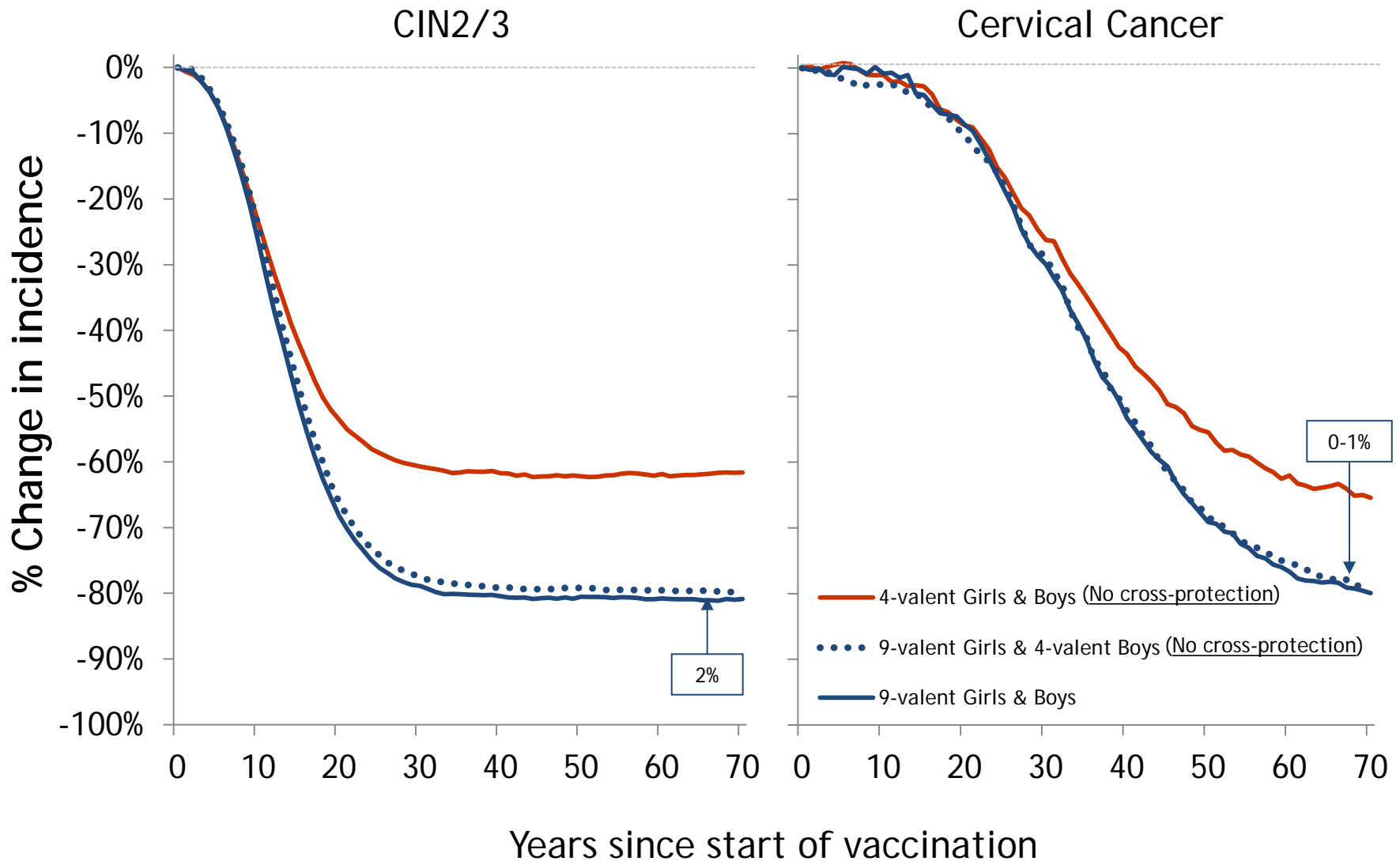


Base case: vaccine-type efficacy=95%, duration=Lifelong

Predictions: Mean estimate generated by the 50 best fitting parameter sets

Effectiveness Sex-specific 9vHPV strategies

Base case, No cross-protection for 4vHPV



Base case: vaccine-type efficacy=95%, duration=Lifelong

Predictions: Mean estimate generated by the 50 best fitting parameter sets

Cost-effectiveness: 9vHPV vs 4vHPV (US HPV-ADVISE model)

No cross-protection for 4vHPV

Vaccination strategy	Comparison strategy	This comparison shows 9vHPV CE for:	Incremental cost per QALY gained
9vHPV females, 4vHPV males	4vHPV both sexes	Females	< \$0 (cost-saving)
9vHPV both sexes	9vHPV females, 4vHPV males	Males	\$31,000
9vHPV both sexes	4vHPV both sexes	Both sexes	< \$0 (cost-saving)

CE: cost-effectiveness. QALY: quality-adjusted life year.

Costs are in 2010 US dollars. Results obtained from Brisson October 2014 ACIP presentation.

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Cost-effectiveness of 9vHPV (both sexes) vs 4vHPV (both sexes)

Summary of results of all 3 models

Model	Incremental cost per QALY gained	
	No 4vHPV cross-protection	With 4vHPV cross-protection
HPV-ADVISE	< \$0 (cost-saving)	< \$0 (cost-saving)
Merck	< \$0 (cost-saving)	Not reported
Simplified	< \$0 (cost-saving)	\$8,100

QALY: quality-adjusted life year. HPV-ADVISE results are in 2010 US dollars. Merck model and simplified model are in 2013 US dollars.

Results of sensitivity analyses: US HPV-ADVISE model

- 9vHPV (both sexes) vs 4vHPV (both sexes)
 - Remained cost-saving in most scenarios
 - Mean cost per QALY gained was < \$0
 - Except 2 scenarios when assuming 4vHPV cross-protection
 - » High coverage scenario: \$4,600 per QALY
 - » Low health care cost scenario: \$6,600 per QALY
 - Uncertainty intervals for the cost per QALY gained
 - < \$10,000 when assuming no 4vHPV cross-protection
 - < \$25,000 when assuming 4vHPV cross-protection

Conclusions: Health impacts

- Current 4vHPV program is expected to reduce HPV-related diseases substantially
- Switching to 9vHPV program is expected to further reduce precancerous lesions and cervical cancer
 - 19% and 14% additional reduction in CIN2/3 and cervical cancer, respectively*
 - 9vHPV for girls provides the great majority of benefits of 9vHPV program for both sexes

CIN: cervical intraepithelial neoplasia.

*US HPV-ADVISE model, after 70 years, in scenario of no cross-protection for 4vHPV.

Slide adapted from Brisson 2014 ACIP.

Conclusions: Cost-effectiveness

- Primary 9vHPV for both sexes is likely cost-saving compared to 4vHPV for both sexes
 - Results consistent across, within models
 - Cost per QALY < \$0 in most scenarios
 - < \$25,000 in all sensitivity analyses
- Analyses of additional 3-dose 9vHPV vaccination for prior 3-dose 4vHPV vaccinees underway
 - Preliminary results highly variable because incremental health benefit is small

Acknowledgements

- US HPV-ADVISE model

 - Marc Brisson, Jean-François Laprise, Mélanie Drolet

- Merck model

 - Matthew Pillsbury, Thomas Weiss, Erik Dasbach

- Simplified model

 - Lauri Markowitz, Susan Hariri, Donatus Ekwueme, Mona Saraiya

 - Unpublished cancer-related data provided by Meg Watson, Jessica King, and Trevor Thompson

- ACIP health economics review:

 - Conflict of interest statement:

 - Chesson: No known conflicts of interest

 - For this presentation, no new models were developed

 - New results (updates and sensitivity analyses) obtained from models reviewed for previous ACIP presentations
 - Existing model structures not changed except to add additional HPV types in 9vHPV