Cost-effectiveness of Influenza Vaccine

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Overview

- Brief introduction to cost-effectiveness analysis
- Cost-effectiveness analysis of influenza vaccination by age and risk group
  - Background
  - Methods
  - Results
  - Conclusions
- Cost-effectiveness evidence & health policy

Cost-effectiveness analysis

- Type of economic evaluation
- Compares the relative costs and outcomes of two or more alternatives
- Can be used by decision makers to assist with resource allocation & policy decisions

Common Misconception

Cost-effective ≠ Cost saving

Cost-Effectiveness Ratios

Cost-effectiveness Ratio:

$$\frac{\text{Costs}_{\text{Vaccination}} - \text{Costs}_{\text{No Vaccination}}}{\text{QALYs}_{\text{Vaccination}} - \text{QALYs}_{\text{No Vaccination}}}$$

QALY = Quality-adjusted life year

Vaccination Recommendations Advisory Committee on Immunization Practices

Program	**Age Group**	**$/QALY***
Rotavirus	Infants	Cost saving
Pertussis	Adolescents	22,000
HPV	Adolescent girls	26,000
Influenza (LAIV)	2-4 yrs, non-high-risk	27,000
Hepatitis A	2 yrs	30,000
Varicella 2nd dose	5 yrs	115,000
Meningococcal	Adolescents	138,000

*Converted to 2009 dollars

Cost-effectiveness of
Seasonal Influenza Vaccination
(Post-H1N1)

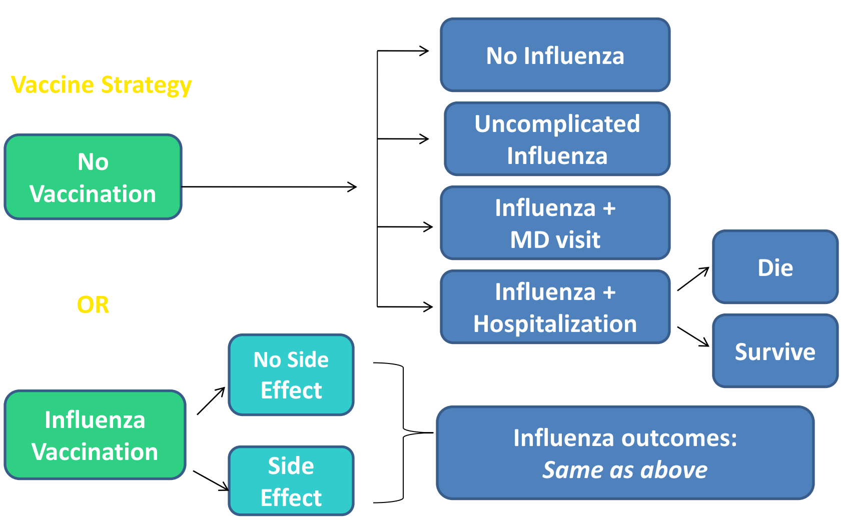
Objectives

- Evaluate the cost-effectiveness of seasonal influenza vaccination under a universal recommendation
- Incorporate new epidemiology – "post-H1N1"
- Include new evidence:
  - Variation in vaccine effectiveness by age
  - Variation in vaccine effectiveness by vaccine type
  - Variation in costs of vaccination by vaccination setting

Methods

- Computer simulation model
  - Compare “vaccination” to “no vaccination”
  - Model inputs based on published and unpublished data, expert panel input
- Target population stratified by age, risk status
- Incremental cost-effectiveness (C/E) analysis
  - Primary endpoint: $ per quality-adjusted life year
  - Secondary endpoints: health benefits, risks, costs
- Sensitivity analysis

Model Schematic



Economic Model: Analysis Plan

- Incremental cost-effectiveness analysis:
  - $ / influenza episode avoided
  - $ / hospitalization averted
  - $ / death averted
  - $ / QALY gained

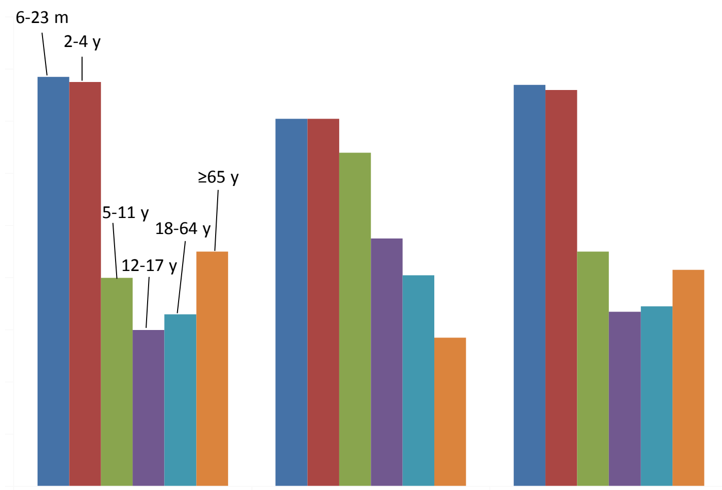
$$\text{C/E Ratio} = \frac{\text{Costs}_{\text{Vaccination}} - \text{Costs}_{\text{No Vaccination}}}{\text{QALYs}_{\text{Vaccination}} - \text{QALYs}_{\text{No Vaccination}}}$$

- Sensitivity Analyses

Model Inputs

- Inputs from both primary and secondary data sources
  - Natural history of influenza in children
  - Effects (reduced incidence rates, adverse events)
  - Costs (direct medical costs, opportunity costs, 2006$)
  - Adjustment for quality-of-life
- Societal perspective
- Timeframe: One year (but does include losses beyond one year associated with death and long-term sequelae)

Influenza illness rates



Model Inputs: Influenza-related probabilities 18-49 yrs, Non-high-risk

Variable	Base Case Value	Range
Prob. of influenza illness	0.069	0.022 – 0.146
Hospitalizations, per 100,000	15.2	3.7 – 86.4
Deaths from influenza, per million	9.5	6.1 – 13.3

Model Inputs: Influenza-related costs (2010$) 18-49 yrs, Non-high-risk

Event	Base Case Value	Range
Non-medically-attended influenza	$3	-
Influenza-related MD visit	$158	$155 - 161
Influenza-related hospitalization	$24,000	$21,000 – 27,000

Model Inputs: Quality of life adjustments

Influenza-related Event	Quality-adjusted life years (QALYs) lost (95% CI)
Influenza	0.008 (0.003, 0.021)
Influenza-related hospitalization	0.016 (0.006, 0.042)
Severe allergic reaction	0.014 (0.009, 0.022)
GBS	0.011 (0.006, 0.022)

Settings

MVC	Mass vaccination clinic, including school-based setting
Physician office Setting	Vaccination at the physician office assuming walk-in hours or other streamlined setting

Model Inputs: Vaccination-related costs 18-49 years

Vaccine dose costs	**IIV: $12** **LAIV: $18**
Administration costs	
Physician Office	$24
Mass Vaccination	$11
Recipient time costs	
Physician Office (2h)	$41
Mass Vaccination (11m)	$4
Adverse event costs	$2
Total Vaccination Costs (Range) **(73% in MVC)**	IIV: $42 (29-79) LAIV: 49 (35-85)

Model Inputs: Vaccine effectiveness

	IIV (Range)	LAIV (Range)
6-23 m	0.56 (0.07-0.85)	NA
2-4 y	0.66 (0.31-0.84)	0.87 (0.77-0.92)
5-11 y	0.71 (0.43-0.84)	0.80 (0.38-0.92)
12-17 y	0.72 (0.46-0.85)	0.78 (0.30-0.92)
18-64 y	0.62 (0.33-0.79)	0.61 (0.34-0.76) (18-49 only)
≥65 y	0.34 (0.14-0.57)	NA

Model Inputs: Vaccination-related adverse events, 18-49 y

	Probability	Range
Systemic reaction	IIV: 0.011 LAIV: 0.026	0.0006-0.005 0.0009-0.021
Anaphylaxis	1 in 4 million	0-0.0000025
GBS	1 in 1 million	0-0.000002

Results: 18-49 yrs, Non-high-risk
Mean outcomes per 1,000 (95% CI)

	Inactivated vaccine	Live attenuated vaccine
Net costs	29,000 (21,000-33,000)	38,000 (30,000-42,000)
Episodes averted	43 (14-95)	42 (15-91)
Hosps averted	0.1 (0-0.3)	0.1 (0-0.3)
Deaths averted	0.05 (0.02-0.11)	0.05 (0.02-0.11)
QALYs saved	1.6 (0.5-3.7)	1.5 (0.5-3.5)

Cost-effectiveness ratio

$$\text{C/E Ratio} = \frac{\text{Costs}_{\text{Vaccination}} - \text{Costs}_{\text{No Vaccination}}}{\text{QALYs}_{\text{Vaccination}} - \text{QALYs}_{\text{No Vaccination}}}$$

$$= \frac{\textbf{Incremental (or Net) Costs}}{\textbf{Incremental QALYs}}$$

$$= \frac{\textbf{\$29,000}}{\textbf{1.6 QALYs}}$$

≈ $18,000/QALY gained

Results: C/E Ratios, Means (95% CI) 18-49 yrs, Non-high-risk

	IIV	LAIV
$/influenza event	$675 ($220-2,300)	$910 ($350-2,900)
$/hospitalization	$307,000 ($68,000-2,252,000)	$413,000 ($101,000-2,881,000)
$/death	$575,000 ($188,000-1,976,000)	$774,000 ($294,000-2,451,000)
$/QALY	$18,000 ($6,000-67,000)	$25,000 ($9,000-86,000)

Results: Mean C/E Ratios, $/QALY

	IIV, High Risk	IIV, Non-high risk	LAIV, Non-high risk
6-23 mos	CS	$9,000	NA
2-4 years	$150	$6,000	$5,000
5-11 years	$900	$7,000	$7,000
12-17 years	$900	$7,000	$7,000

*Base-case assumes all children under 5 to be vaccinated in physician office; mix of settings for children aged 5 and older; CS = Cost Savings

Results: Mean C/E Ratios*, $/QALY

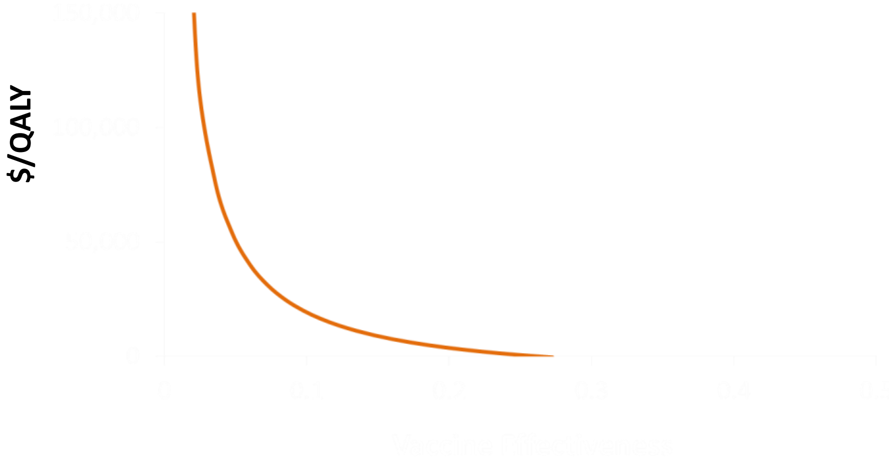
	IIV, High Risk	IIV, Non-high risk	LAIV, Non-high risk
18-49 years	$2,000	$18,000	$25,000
50-64 years	CS	$20,000	NA
≥65years	CS	NA	NA

*Assumes mix of vaccination settings; CS = Cost Savings

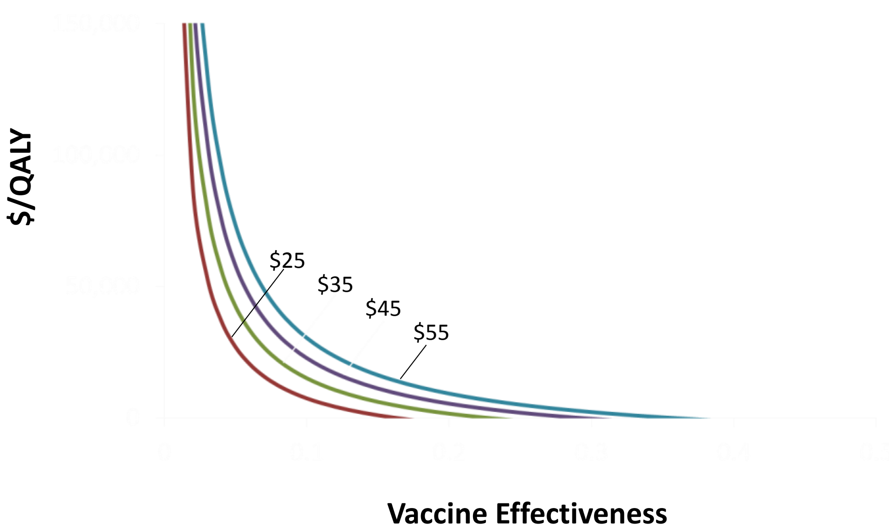
Results: Sensitivity Analyses

- Cost-effectiveness results not sensitive to:
  - Probability of vaccine adverse events
  - Costs of influenza events
- Results sensitive to:
  - Influenza illness attack rate
  - Vaccine effectiveness
  - Costs of vaccination/vaccination setting

Sensitivity analysis:
Vaccine effectiveness, ≥65 y



2-way Sensitivity Analysis:
Vaccine effectiveness & vaccination costs, ≥65 y



Limitations

- Effects of indirect protection not considered
- Limited data regarding some key assumptions
- Quality adjustments for adverse events may not reflect increased value associated with causing harm

Summary: Role of Cost-effectiveness Evidence

- Rarely used for global coverage decisions
- More often used for identifying target populations
- Focus on sensitivity analysis

Policy Implications – Seasonal Influenza Vaccination

- Cost-effectiveness of influenza vaccination varies by
  - age and risk status
  - vaccination setting
- Cost-effectiveness evidence supports universal recommendation
- Lower-cost settings can substantially improve efficiency of vaccination

Thank You