Cost-effectiveness of Pertussis Vaccine Substitution for Tetanus Booster in Prevention of Pertussis in Adults 65 Years and Older

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Objective

- **To evaluate the cost-effectiveness of a one-time substitution of Tdap for Td in healthy adults in preventing adult disease and complications**

- **Perspectives:**
  - Health system (medical cost)
  - Societal (productivity loss)

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Cost-effectiveness Model

- **Strategy:**
  - one-time Tdap substitution for Td vs. no substitution at age 65
- **Cohort population: healthy 65 year olds**
- **Analytic time frame: 10 years**
- **Health Outcomes:**
  - Cases, outpatient illnesses, hospitalizations, pneumonias, deaths
- **Economic Outcomes:**
  - Cost per case averted, cost per quality adjusted life year (QALY) saved

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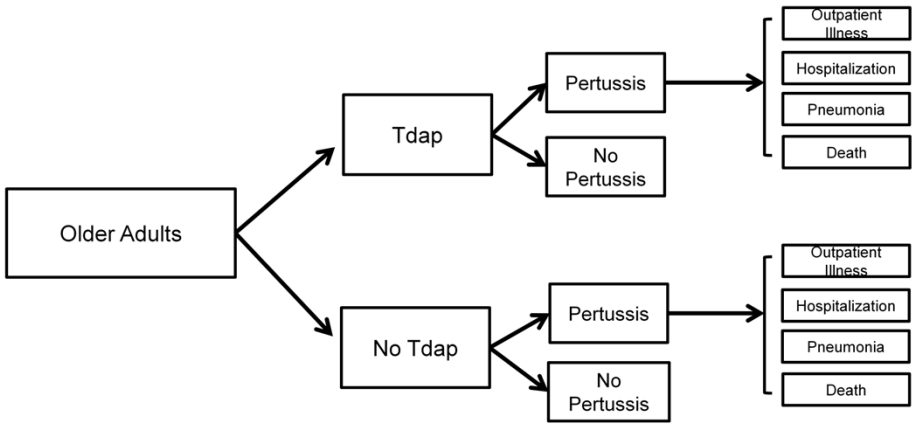
Decision Analytic Model



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General Parameters of the Model

Variable	Base-Case Estimate	Sensitivity Analyses	Sources
Disease Incidence	100x mean surveillance incidence (104 cases per 100,000)	10-200x incidence	Laserre, 2011 NNDSS Nennig, 1996 Strebel, 2001 Ward, 2005
Population			
Cohort of 65 year-olds	2,603,715		US Census
Age-specific mortality	Varies by year of age		NCHS
Outcome Probabilities (%)	Mean % of cases with outcomes		NNDSS
Outpatient	Varies by year of age (86-95)		
Hospitalization	Varies by year of age (5-14)		
Pneumonia	Varies by year of age (3-8)		
Death	0.05		
% of non-hospitalized cases seeking care	50	33-100	Long, 1990 Saffar, 2011 Ward, 2006 Author Assumption

NNDSS: National Notifiable Diseases Surveillance System
NCHS: National Center for Health Statistics

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Key Vaccine Parameters of the Model

Variable	Base-Case Estimate	Sensitivity Analyses	Sources
Vaccine Efficacy (%)*	70	60-90	Blatter 2008; Frampton, 2006; Pichichero, 2006; Skoff, 2011; Ward, 2005; Wei, 2010; Weston 2012
Vaccine Waning*	5 percentage point reduction in efficacy each year	20% reduction in efficacy each year	Lee, 2007 Author assumption
Vaccine Coverage (%)	50	10-70	NHIS, 2009
Vaccine Adverse Event (%) (Incremental, Tdap vs Td)			Lee, 2007
Local Reaction	2		
Systemic Reaction	1		
Anaphylaxis	0.0001		

* Immunosenescence indirectly incorporated via range of efficacy rates and immune waning.

NHIS: National Health Interview Survey

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Key Cost Parameters of the Model*

Variable	Base-Case Estimate	Sources
Direct (Medical) Costs		Thomson Reuters MarketScan (2000-9)
Outpatient	217	
Hospitalization	11,037	
Hospitalization + Pneumonia	11, 276	
Income loss due to hospitalization	175	BLS
Mean number of days hospitalized	4	Thomson Reuters MarketScan (2000-9)
Adverse Events Costs		Lee, 2007
Local Reaction	1.12	
Systemic Reaction	1.12	
Anaphylaxis	2,335	
Program Costs		CDC Vaccine Price
Incremental Increase, Tdap vs Td	17.16	
Discount Rate	3%	

* 2010 US Dollars

BLS: Bureau of Labor Statistics

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Health Utility Parameters of the Model

Utility	Value	Source
Outpatient Illness	0.85	Lee, 2005
Hospitalization	0.81	Lee, 2005
Pneumonia	0.82	Lee, 2005
Duration of Disease	56 days	de Serres, 2000 Gilberg, 2002 Postels-Mutani, 1995 Schmitt-Grohe, 1995 Senzilet, 2001 Yih, 2000

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Sensitivity Analyses

- **One-way analyses**
  - Incidence, vaccine efficacy, immune waning, coverage
- **Multi-way analyses**
  - Most cost-effective and least cost-effective scenarios
    - Key model inputs: incidence, efficacy, immune waning

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RESULTS

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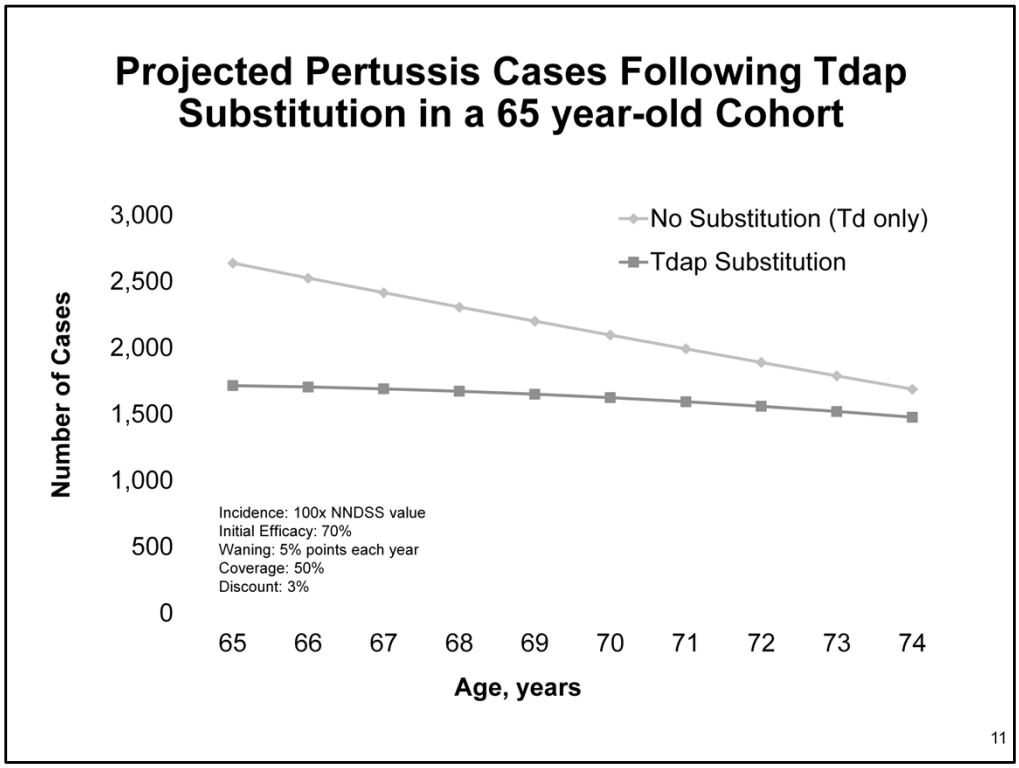
Projected Pertussis Cases Following Tdap Substitution in a 65 year-old Cohort
3,000
2,500
2,000
1,500
1,000
500
0
Number of Cases
No Substitution (Td only)
Tdap Substitution
Incidence: 100x NNDSS value
Initial Efficacy: 70%
Waning: 5% points each year
Coverage: 50%
Discount: 3%
65
66
67
68
69
70
71
72
73
74
Age, years
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Reduction in Health Outcomes Following Tdap Substitution in a 65 year-old Cohort

Outcomes	Base-Case Reduction Number (%)
Cases	5,335 (25%)
Outpatient Illnesses (treated)	2,461 (25%)
Hospitalizations	388 (24%)
Pneumonias	238 (23%)
Deaths	27 (25%)

Base-case parameters

Incidence: 100x NNDSS value
Initial efficacy: 70%
Waning: 5% point decrease each year
Vaccine coverage: 50%

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Cost-effectiveness Summary of Tdap Substitution in a 65 year-old Cohort*

Cost Effectiveness Ratio	Base-Case
Cost per case averted	3,263
Cost per hospitalization averted	44,903
Cost per pneumonia averted	73,122
Cost per death averted	652,525
Cost per life-year saved	42,182
Cost per QALY saved	30,946

*2010 US Dollars

Base-Case Parameters
Incidence: 100x NNDSS value
Initial Efficacy: 70%
Waning: 5% point decrease each year
Vaccine Coverage: 50%

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Cost-Effectiveness Summary of Tdap in 65 year olds: One way Sensitivity Analyses*

Cost Effectiveness Ratio	Base-Case	Incidence		Efficacy		Immune Waning (20%)
		Low (10X)	High (200X)	Low (60%)	High (90%)	
Cost per case averted	3,263	41,025	1,165	4,334	2,045	5,244
Cost per life-year saved	42,182	530,403	15,059	55,521	26,715	65,506
Cost per QALY saved	30,946	389,123	11,047	40,837	19,541	48,514

*2010 US Dollars

Base-Case Parameters
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Base-Case Parameters
Incidence: 100x NNDSS value
Initial Efficacy: 70%
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Vaccine Coverage: 50%

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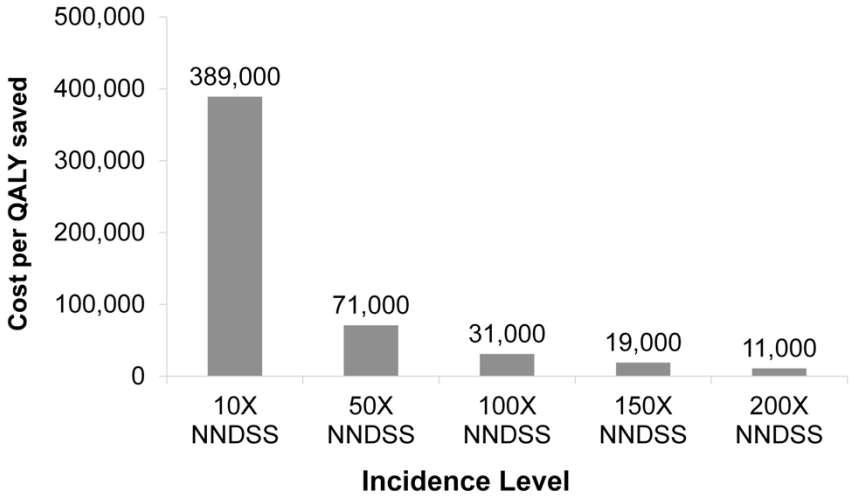
Cost per QALY Saved with Tdap in 65 year-olds, at Varied Levels of Pertussis Incidence*



* 2010 US Dollars

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Multi-Way Sensitivity Analyses Summary

Outcomes	Number Prevented (%)		
	Base-Case	Most Cost-Effective	Least Cost-Effective
Cases	5,335 (25%)	20,973 (49%)	63 (3%)
Hospitalizations	388 (24%)	1,544 (47%)	4 (3%)
Pneumonias	238 (23%)	953 (47%)	3 (3%)
Deaths	27 (25%)	105 (49%)	0.3 (3%)
Cost per case averted	$3,263	$550	$70,699
Cost per QALY saved	$30,946	$5,260	$654,061

Base-Case Parameters
Incidence: 100x NNDSS value
Initial Efficacy: 70%
Waning: 5% point decrease each year
Vaccine Coverage: 50%

Most Cost-Effective Parameters
Incidence: 200x NNDSS value
Efficacy: 90%
Waning: 5% point decrease each year
Vaccine Coverage: 70%

Least Cost Effective Parameters
Incidence: 10x NNDSS value
Initial Efficacy: 60%
Waning: 20% decrease each year
Vaccine Coverage: 10%

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Assumptions of the Analysis

- Incidence and under-reporting
- Efficacy and immune-waning
- Health utilities
- Costs
- Comorbidities

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Conclusions

- **Substituting Tdap for Td**
  - Moderate decrease in number of cases and other outcomes
  - May be a cost-effective intervention
- **Incidence level drives cost-effectiveness**
  - As incidence level increases, vaccination more cost-effective

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