Pertussis in Adolescents and Adults: Should We Vaccinate?

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Harvard Pilgrim Health Care
and Harvard Medical School
Messages

• Pertussis in adolescents and adults is increasing and costly

• Vaccination could be beneficial and cost-effective

• Need better data on incidence
Reported Pertussis Cases
U.S., 1922-2000

Number of cases

Year


0 50,000 100,000 150,000 200,000 250,000 300,000

DTP
Reported Pertussis Cases

Number of cases

Year

0 10,000

0 2,000

1980 1990 2000

Number of cases
Pertussis in Infants

- Last year: 19 deaths, all infants
- Incidence in infants increasing
- Suggests pertussis circulation is increasing
Who Infects Infants?

- Parent
- Sibling
- Caregiver
- Other
- Unknown
Whooping Cough Makes Comeback, Striking Teens and Young Adults

ASSOCIATED PRESS

Whooping Cough Returns To U.S. as Immunity Wanes

By MARILYN CHASE
Acellular Pertussis Vaccines for Adolescents and Adults

- Licensed in Canada, Germany, Australia, France
- Combined with Td → TdaP
- U.S. trial suggests effective
Why Is This Not a Slam Dunk?

• Vaccination risks should be weighed
• Immunity wanes
• Vaccine price is as yet unknown
• Vaccine coverage is hard to attain
Programmatic Options

• Adolescents
• Adolescents + boosters every 10 years
• Adults at 20 years old
• Adults at 20 years old + boosters every 10 years
Figure 5. Drawing by S. Harris, © 1979 The New Yorker Magazine.
Joint Initiative in Vaccine Economics (JIVE)

Cost-effectiveness analyses of policy options for pertussis, influenza, polio, and hepatitis B
Cost-Effectiveness of Adolescent & Adult Pertussis Vaccination in the U.S.

Grace M. Lee, MD, MPH, Stephanie Schauer, PhD, Susan Lett, MD MPH, Charles LeBaron, MD, MPH, Trudy Murphy, MD, Tracy Lieu, MD, MPH, and collaborators

Children’s Hospital Boston, Massachusetts Department of Public Health, Centers for Disease Control & Prevention, and Harvard Medical School
Acknowledgments

NIP/Immunization Services Division
Lance Rodewald, Abigail Shefer,
Donna Rickert, Shannon Stokely

NIP/Epidemiology and Surveillance Division
Melinda Wharton, Trudy Murphy,
Kris Bisgard, Charles LeBaron, James Singleton,
John Glasser, Peng-Jun Lu

Expert panel
Kris Bisgard, Kathy Edwards,
Scott Halperin, Susan Lett, Colin Marchant,
Margaret Rennels, Joel Ward, Melinda Wharton
Questions

• Do the health benefits outweigh the vaccine risks?

• Will vaccination save money?

• Will it be cost-effective, relative to other health interventions?
Cost-Effective ≠ Cost-Saving

Health Outcomes

Costs
Vaccines Are Cost-Effective

$ per life-year saved

50,000
Mammography
Pneumococcal vaccination

25,000
Pap screening
Colorectal cancer screening

0
Hepatitis B vaccination
Varicella vaccination
DTP vaccination
MMR vaccination
Hib vaccination
Polio vaccination

NOT COST-SAVING

COST-SAVING
Decision Tree

- No vaccination
  - Pertussis
  - No pertussis
- Vaccination

Public health policy
Outcomes of Pertussis

Pertussis in adolescents or adults
- Mild cough illness
- Severe cough illness
- Pneumonia

Pertussis in infants
- Respiratory sequelae
- Neurologic sequelae
- Death
## Pertussis Probabilities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Base Case Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incidence of pertussis</strong></td>
<td></td>
</tr>
<tr>
<td>Adolescents</td>
<td>114 per 100,000</td>
</tr>
<tr>
<td>Adults</td>
<td>8 per 100,000</td>
</tr>
<tr>
<td><strong>Pneumonia after pertussis</strong></td>
<td></td>
</tr>
<tr>
<td>Adolescents</td>
<td>1%</td>
</tr>
<tr>
<td>Adults</td>
<td>3%</td>
</tr>
</tbody>
</table>
Outcomes of Vaccination

Vaccination program

- Not vaccinated
  - No adverse events
  - Local reaction
  - Systemic reaction
  - Anaphylaxis

- Vaccinated
# Vaccine Probabilities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Base Case Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine coverage:</td>
<td></td>
</tr>
<tr>
<td>Adolescents</td>
<td>78%</td>
</tr>
<tr>
<td>Adults</td>
<td>40%</td>
</tr>
<tr>
<td>Vaccine adverse events:</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>22%</td>
</tr>
<tr>
<td>Systemic</td>
<td>5%</td>
</tr>
<tr>
<td>Vaccine effectiveness</td>
<td>92% [30-95%]</td>
</tr>
</tbody>
</table>
Preliminary Results:
Health Outcomes*
## Preliminary Results: Health Outcomes*

<table>
<thead>
<tr>
<th>Policy</th>
<th>Cases Prevented</th>
<th>Vaccine Adverse Events (mostly local)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescents</td>
<td>23,000</td>
<td>840,000</td>
</tr>
<tr>
<td>Adols + boosters</td>
<td>27,000</td>
<td>2.6 million</td>
</tr>
<tr>
<td>Adults at 20 yrs</td>
<td>920</td>
<td>440,000</td>
</tr>
<tr>
<td>Adults + boosters</td>
<td>3600</td>
<td>1.8 million</td>
</tr>
</tbody>
</table>

*For 2002 birth cohort assuming 100% surveillance & no change in infant transmission*
Dilemmas

• How should we weigh preventing pertussis, vs. avoiding vaccine adverse events?

• Pertussis vaccination prevents few deaths

• Use time trade-off questions to get econometric measure -- quality-adjusted life-years
Time Trade-Off

Example: Severe cough

How many days or weeks would you be willing to give up from the end of your life to avoid severe cough for 8 weeks? The cough can cause vomiting several times a week, difficulty eating or drinking, and difficulty sleeping.
Do Health Benefits Outweigh Vaccine Risks?
## Do Health Benefits Outweigh Vaccine Risks?

<table>
<thead>
<tr>
<th>Policy option</th>
<th>If NO infant disease prevented</th>
<th>If ALL infant disease prevented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescents</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adols + boosters</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Adults at 20 yrs</td>
<td>No</td>
<td>Yes</td>
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Questions

• Do the health benefits outweigh the vaccine risks?

• Will vaccination save money?

• Will it be cost-effective, relative to other health interventions?
Costs of Pertussis in Adolescents & Adults
Massachusetts
Analysis of Medical Costs

- Retrospective analysis
- 2,800 cases of confirmed pertussis in Massachusetts, 1998-2000
- Utilization of health services
- Costs of services from national sources
Medical Costs
Adolescents = $300

- Hospitalizations
- Office visits
- Abx for contacts
- Abx for case
- CXRs
Survey on Non-Medical Costs

- Include work-loss and other expenses
- Psychological costs
- Telephone interviews
- 400 adolescent and adult cases
### Non-Medical Costs Are High

<table>
<thead>
<tr>
<th>Age group</th>
<th>Medical</th>
<th>Non-medical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescent</td>
<td>300</td>
<td>60% x medical</td>
</tr>
<tr>
<td>Adult</td>
<td>&gt;300</td>
<td>150% x medical</td>
</tr>
</tbody>
</table>
Cost of Vaccination?

Vaccine price = ?

Vaccine administration = 0 if added to Td

Program costs = ?

Temporary assumption: $25
Cost of vaccination = $25
Will Vaccination Save Money?
Probably not:
Cost of vaccination = $25
Will Vaccination Save Money? Probably not:

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<tr>
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<th>If <strong>NO</strong> infant disease prevented</th>
<th>If <strong>ALL</strong> infant disease prevented</th>
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<tr>
<td>Adolescents</td>
<td>No</td>
<td>No</td>
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<td>No</td>
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Cost of vaccination = $25
Will Vaccination Be Cost-Effective?
Cost < $50,000 per QALY saved
Cost of vaccination = $25

Will Vaccination Be Cost-Effective?
Cost < $50,000 per QALY saved

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Sensitivity to Incidence of Pertussis and Cost of Vaccination

Massachusetts (base case)

- 2-fold
- 5-fold

Cost of Vaccination $5 $10 $15 $20 $25
Sensitivity to Incidence of Pertussis and Cost of Vaccination

Adolescents – Cost-effective

Adolescents – Cost-saving

Massachusetts (base case)

5-fold

2-fold

$5 $10 $15 $20 $25

Cost of Vaccination
Preliminary Findings

• Tradeoffs depend greatly on:
  – True incidence of disease
  – Cost of vaccination (including vaccine price and program costs)
  – Effects on infant disease
Messages

• Pertussis in adolescents and adults is increasing and costly

• Vaccination could be beneficial and cost-effective

• Need better data on incidence
Slides following this slide are leftovers
Markov Model

- Full Immunity
- Some Immunity
- No Immunity
Non-medical Costs

Adolescents ($180)
- Babysitting: 11%
- Transportation: 17%
- Time at visits: 12%
- Work missed: 60%

Adults ($570)
- Babysitting: 5%
- Transportation: 4%
- Time at visits: 9%
- Work missed: 82%
Outcome Measures

- Cases of pertussis prevented
- Adverse effects
- Total cost
- Life-years saved
- Quality-adjusted life-years saved
- $ per QALY saved
Next Steps

- Add a “cocoon” strategy to the model
- Need estimates of impact on infant disease from dynamic models
- Include public health costs
Other Adolescent Time Costs

- 87% missed school due to illness
- Average days missed from school
  - 6.1 days (0.4-32 days)
- 27% of adolescents had jobs
- Average days missed from work
  - 4.8 days (0.5-15 days)
Public Health Costs

- Average costs of 3 states with high incidence of pertussis:
  - Surveillance--$202,000 per year
  - Health care outbreak--$33,000 per year
  - School outbreak--$21,000 per year
- Average cost per state--$256,000
- Average cost for U.S.--$12.8 million