Pertussis Epidemiology and Vaccination in the United States and the Latin American Pertussis Project

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Reported NNDSS pertussis cases: 1922-2012*

*2011 data are provisional; 2012 data are provisional through week 37.

SOURCE: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System and 1922-1949, passive reports to the Public Health Service
Reported pertussis incidence by age group: 1990-2011

Incidence rate (per 100,000)

Year

SOURCE: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System
Pertussis Incidence among Infants 2001-2009

Hospitalizations and Deaths
% Total Cases, 2001-2009

Hospitalization % of cases

Death % of cases

Pertussis Immunization in the US

• Whole-cell vaccines/DTwP (1940s)
• DTaP (1990s)
  – Infants at 2, 4, 6 months (1997)
  – Toddlers at 15-18 months (1992)
  – Pre-school at 4-6 years (1992)
• Tdap
  – Adolescents at 11-12 years (2005)
  – Adults who have not received (2005)
High DTaP coverage among children aged 19 through 35 months — 2004–2011

CDC National Immunization Survey
Increasing Tdap coverage among adolescents aged 13–17 years — 2006–2011

- 2006: 10.8%
- 2007: 30.4%
- 2008: 40.8%
- 2009: 55.6%
- 2010: 68.7%
- 2011: 78.2%

CDC. National, State, and Local Area Vaccination Coverage among Adolescents Aged 13-17 Years - United States, 2009 MMWR 2010 ;59(32);1018-1023.
Pertussis cases by age — United States, 2004
n=25,827

Cases

Age (years)

Acellular Only

Whole Cell and Acellular

Transition Period

Vaccine Type Received*

0 200 400 600 800 1000 1200 1400 1600 1800

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Pertussis cases by age — United States, 2010
n=27,550
Incidence rate ratios of pertussis among children 7-10 years and adolescents 11-18 years — 1990–2010

[Graph showing rate ratios over years for 7-10 years vs others (not 11-18) and 11-18 years vs others (not 7-10).]
# DTaP VE and Duration of Protection Estimates—California, 2010

<table>
<thead>
<tr>
<th>Model *</th>
<th>Case (n)</th>
<th>Control (n)</th>
<th>VE, %</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall VE, All Ages</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 dose</td>
<td>53</td>
<td>19</td>
<td>Ref</td>
<td>--</td>
</tr>
<tr>
<td>5 doses</td>
<td>629</td>
<td>1,997</td>
<td>88.7</td>
<td>79.4 – 93.8</td>
</tr>
<tr>
<td>Time since 5th dose</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0 doses</td>
<td>53</td>
<td>19</td>
<td>Ref</td>
<td>--</td>
</tr>
<tr>
<td>&lt; 12 months</td>
<td>19</td>
<td>354</td>
<td>98.1</td>
<td>96.1 – 99.1</td>
</tr>
<tr>
<td>12 – 23 months</td>
<td>51</td>
<td>391</td>
<td>95.3</td>
<td>91.2 – 97.5</td>
</tr>
<tr>
<td>24 – 35 months</td>
<td>79</td>
<td>366</td>
<td>92.3</td>
<td>86.6 – 95.5</td>
</tr>
<tr>
<td>36 – 47 months</td>
<td>108</td>
<td>304</td>
<td>87.3</td>
<td>76.2 – 93.2</td>
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<tr>
<td>48 – 59 months</td>
<td>141</td>
<td>294</td>
<td>82.8</td>
<td>68.7 – 90.6</td>
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<tr>
<td>60+ months</td>
<td>231</td>
<td>288</td>
<td>71.2</td>
<td>45.8 – 84.8</td>
</tr>
</tbody>
</table>

* Accounting for clustering by county and provider
Annual Incidence by State, 2012*

2012 incidence 10.0
(n=30,908)

*2012 data are preliminary and subject to change. Data represent cases received at CDC through Week 39.

Source: CDC National Notifiable Disease Surveillance System, 2012

2011 Census data used for population estimates; Incidence is per 100,000 population
Pertussis cases by age — United States, 2012

<table>
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<tr>
<th>Vaccine Type Received*</th>
<th>Acellular Only</th>
<th>Transition Period</th>
<th>Whole Cell and Acellular</th>
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</table>

CDC. MMWR 2012;61(28);517-522.

*2012 data are provisional and reflect cases reported to NNDSS through September 4.
SOURCE: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System and 1922-1949, passive reports to the Public Health Service
Summary and Working Hypothesis

- Pertussis incidence has increased since 1980s
- Resurgence of childhood disease despite high DTaP coverage
  - Excellent initial vaccine effectiveness
  - Moderate and immediate waning of immunity
- Re-emergence of adolescent disease
  - Tdap effectiveness about 70%\(^1\), duration of protection unknown
  - Tdap boost in DTaP recipients may wane more quickly\(^3\)
- Switch to aP vaccines is changing pertussis epidemiology
  - i.e. a problem of susceptibility *despite* vaccination
  - Waning immunity driving disease incidence

\(^3\)CDC. MMWR 2012;61(28):517-522.
Alternate Hypotheses for Disease Emergence

- **Surveillance bias**
  - Contributing to increasing incidence
  - *However*, cohort effect evident

- **Vaccine antigen content**
  - Minor variability among multi-component vaccine efficacy
  - *However*, much mix-and-match in US children

- **Selective pressure of vaccination on circulating strains**
  - Vaccine–antigen mismatch occurs
  - Mixed evidence for contribution of pertussis toxin promoter 3 (ptxP3)\(^1-4\)
  - *However*, short-term vaccine effectiveness excellent

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\(^1\)Mooi et al. EID 2009;15:1206-1213.
Changes in frequency of dominant vaccine-antigen alleles among *Bordetella pertussis* isolates—US, 1935-2009

Maximizing the Vaccination Program

Expanding the Evidence for New Vaccines
Improving regional capacity for surveillance

LATIN AMERICAN PERTUSSIS PROJECT
LAPP Strategy

- Evaluate surveillance and lab systems
- Transfer knowledge and technology (rPCR, culture, serology)
- Contract and supervise national coordinator
- Implement lab QC/QA program

Mentorship, guidance, technical assistance
How far we’ve come, and where we’re going...

- **Tremendous effort**
  - 12 visits to 3 countries
  - >35,000 persons-hours contributed by all partners

- **Improving surveillance capacity in unique settings**
  - rPCR has reduced inconclusive laboratory results in Argentina
  - Increased proportion of cases confirmed in Mexico
  - 100% reporting, decreased time to report in Panama
  - Improved physician knowledge in Panama

- **Improved understanding of pertussis**

- **Sustaining, expanding the network**
THANK YOU