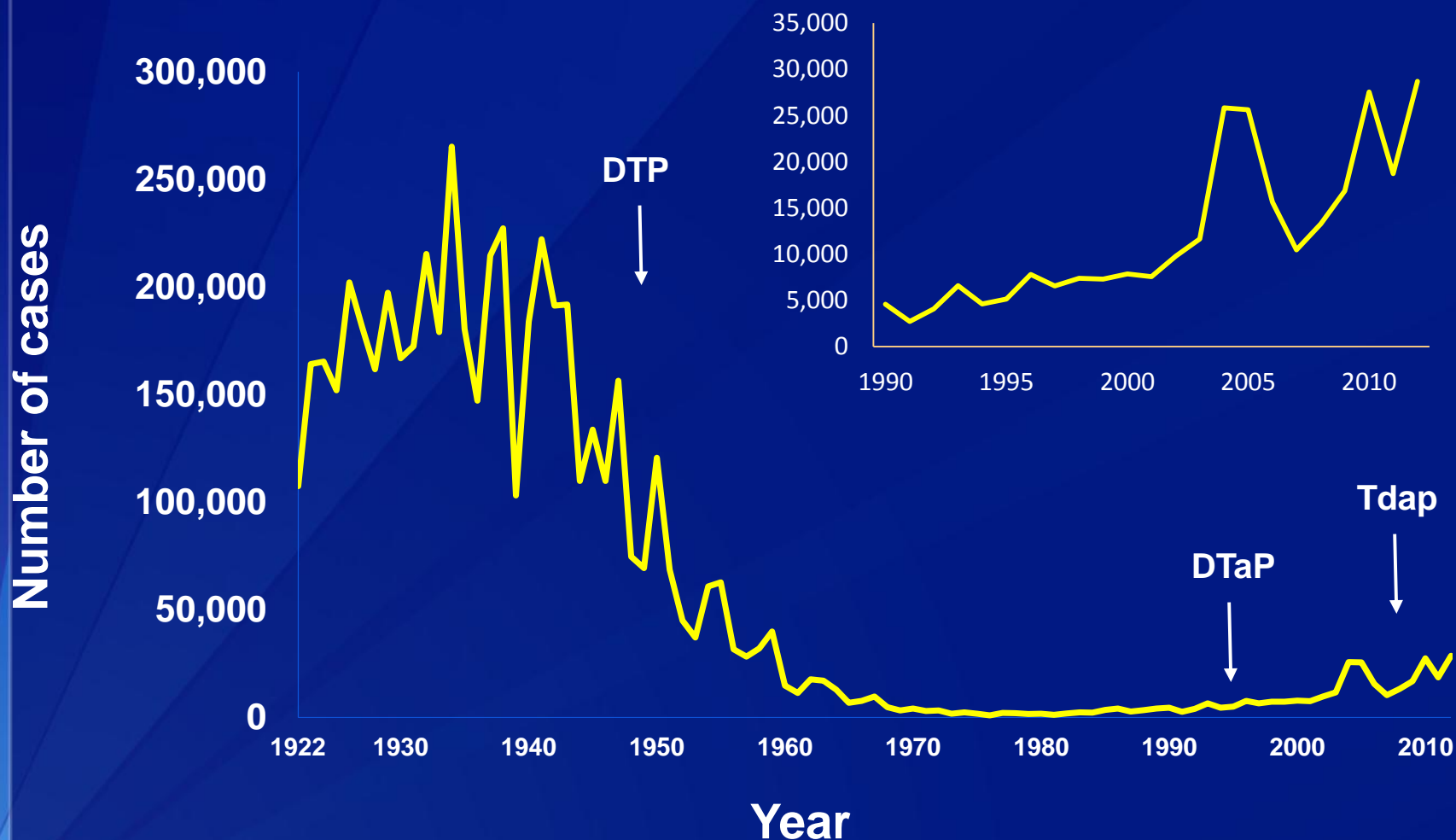


Pertussis Epidemiology and Vaccination in the United States and the Latin American Pertussis Project

Thomas Clark, MD, MPH
Epidemiology Team Lead
Meningitis and Vaccine Preventable Diseases Branch

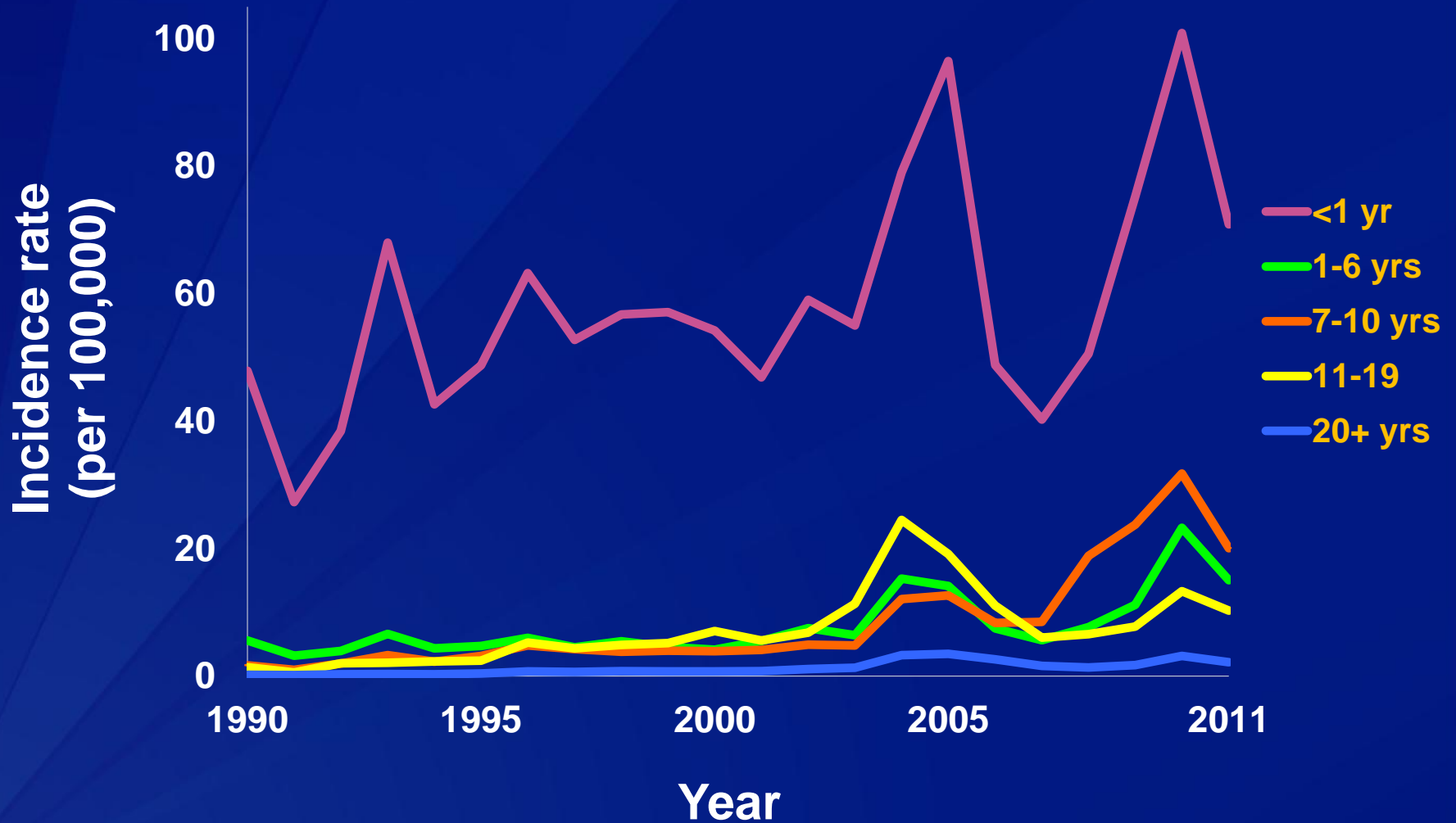
Reported NNDSS pertussis cases: 1922-2012*



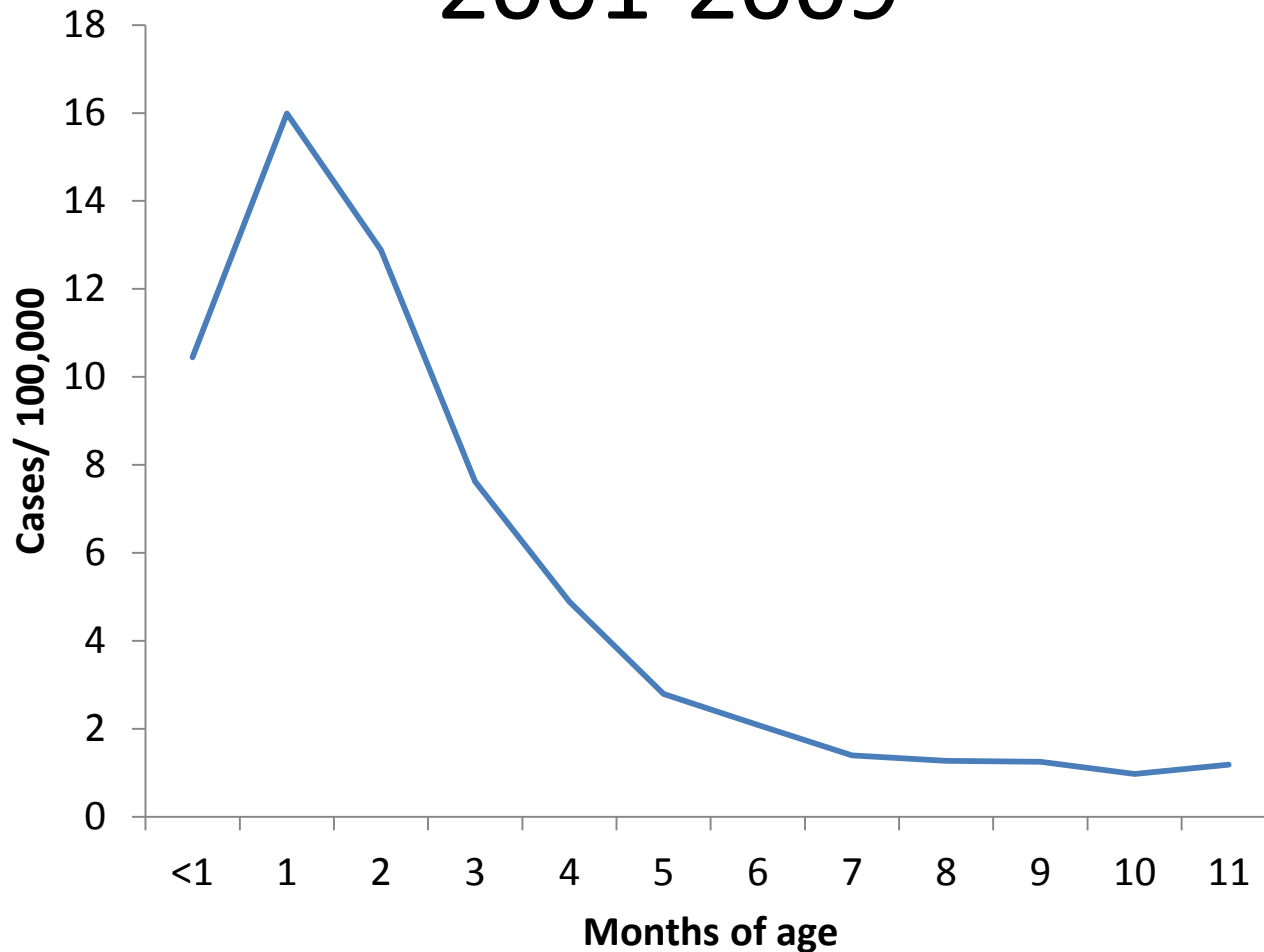
*2011 data are provisional; 2012 data are provisional through week 37.

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

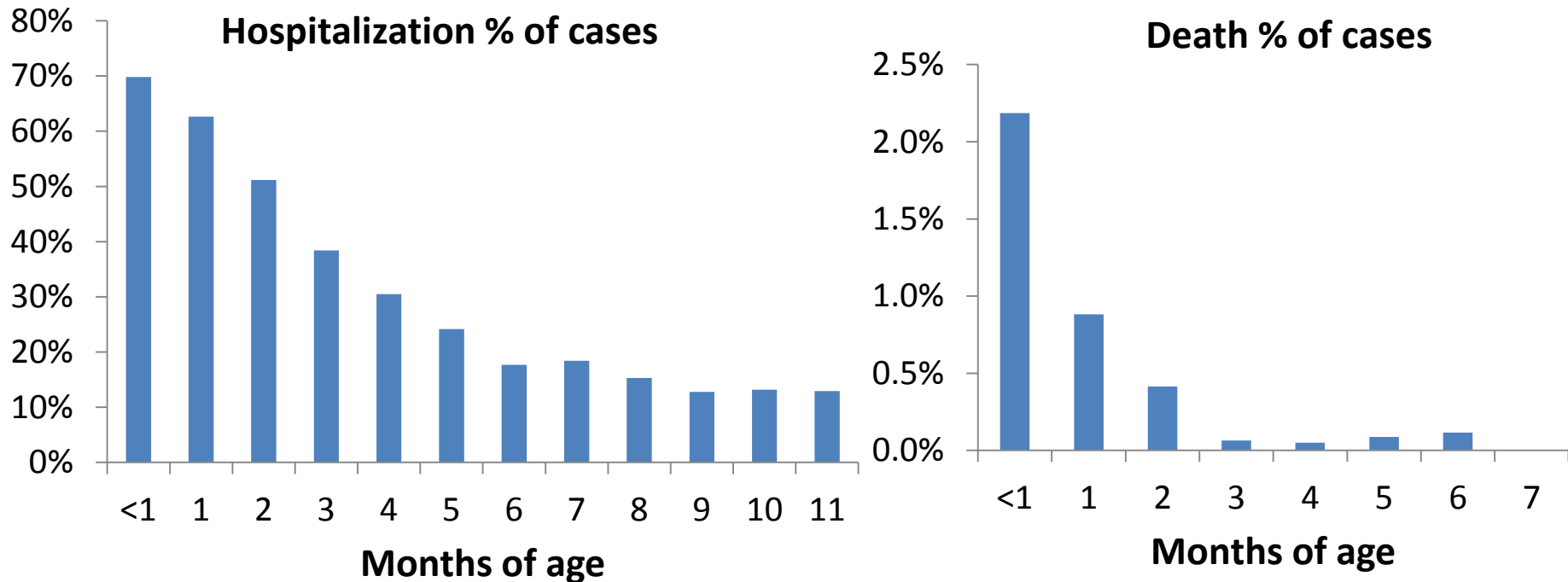


Pertussis Incidence among Infants 2001-2009



Source: CDC, National Pertussis Surveillance System and Supplemental Pertussis Surveillance System (2010)

Hospitalizations and Deaths % Total Cases, 2001-2009

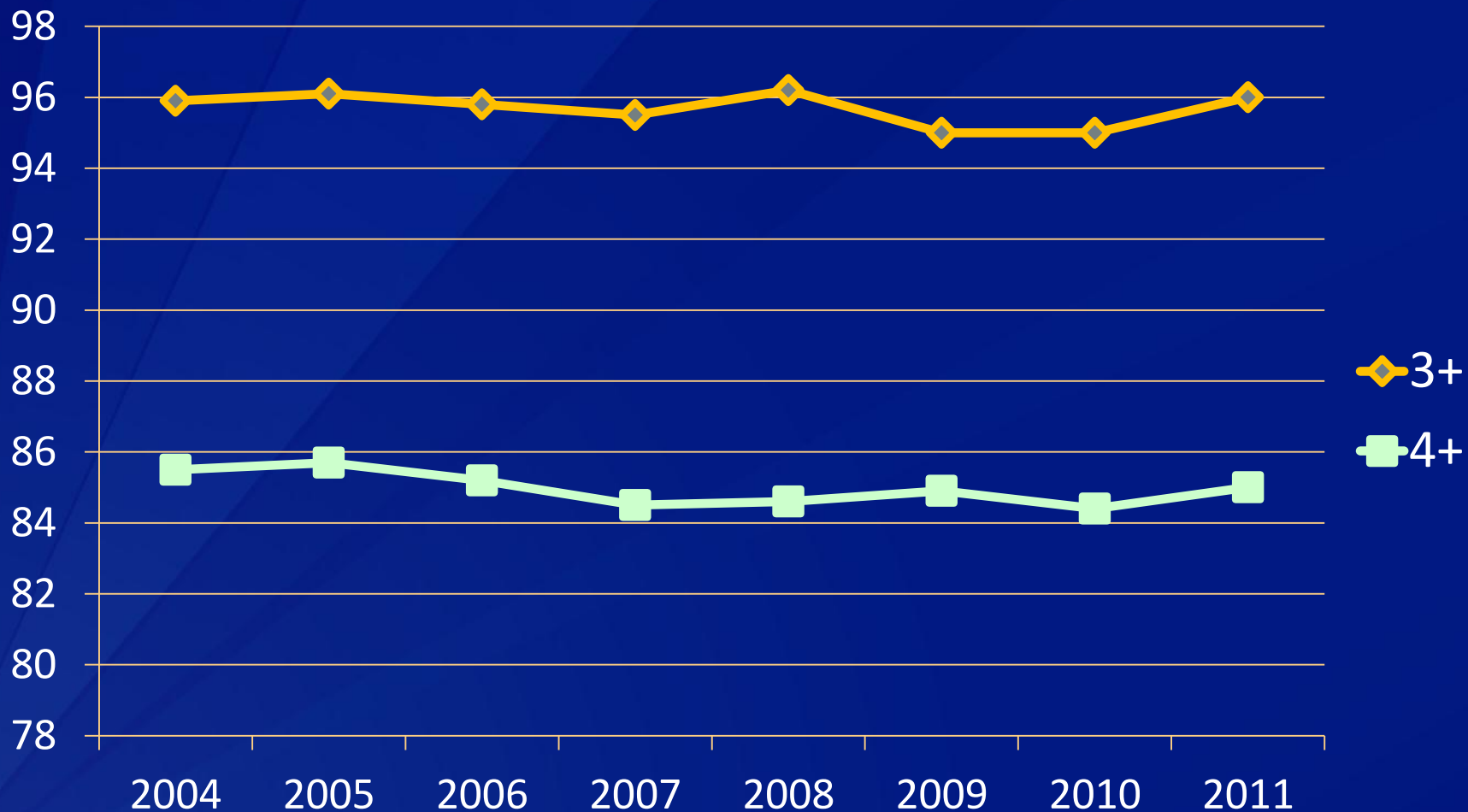


Source: CDC, National Pertussis Surveillance System and Supplemental Pertussis Surveillance System (2010)

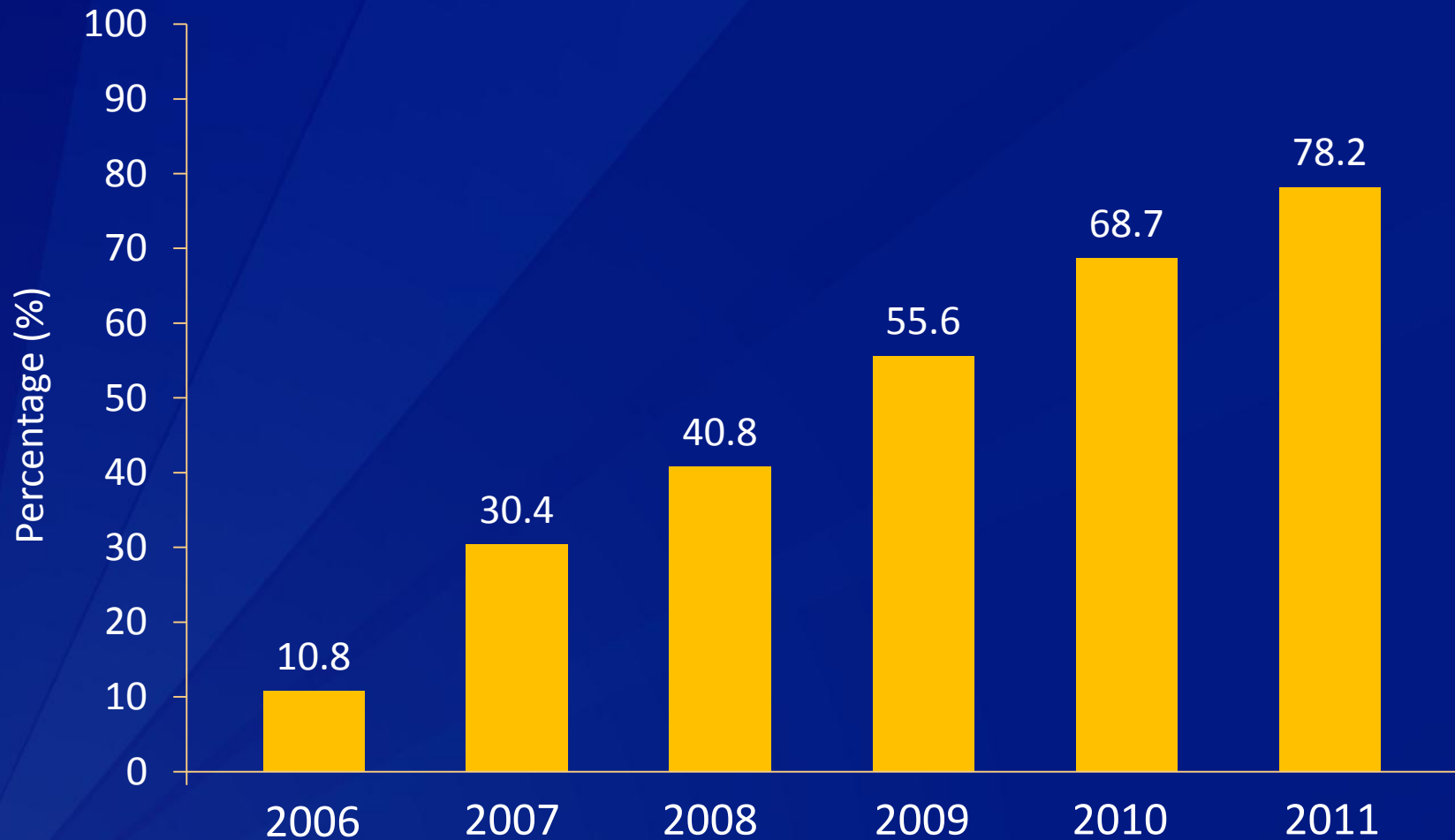
Pertussis Immunization in the US

- 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



Increasing Tdap coverage among adolescents aged 13–17 years — 2006–2011



CDC. National, State, and Local Area Vaccination Coverage Among Adolescents Aged 13-17 Years - United States, 2008. MMWR 2008;58(36);997-1001.

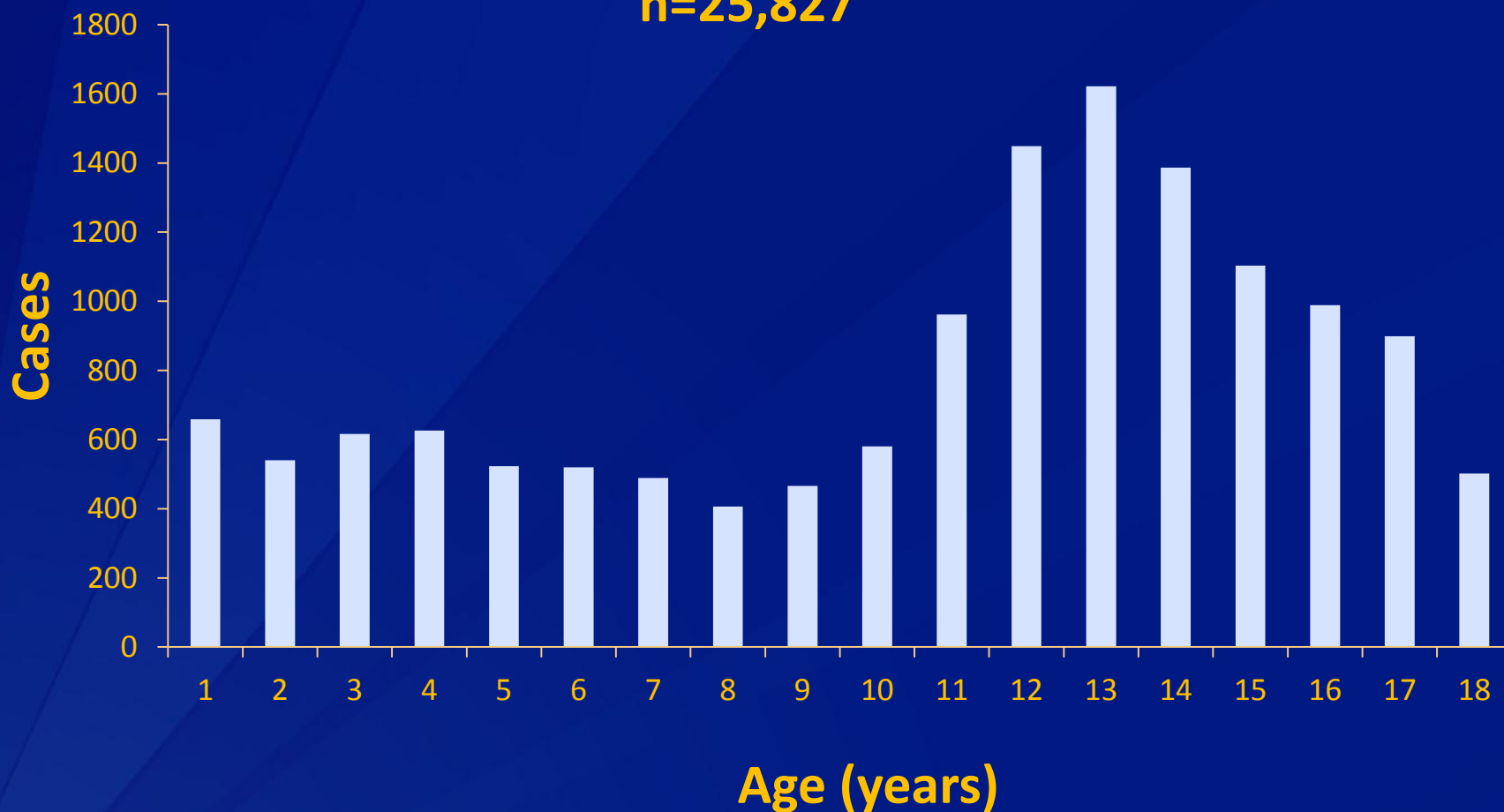
CDC. Vaccination Coverage Among Adolescents Aged 13-17 Years – United States, 2007. MMWR 2008;57(40)1100-1103.

CDC. Vaccination Coverage Among Adolescents Aged 13-17 Years– United States, 2006. MMWR 2007;56(34) 885-888.

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



Vaccine
Type
Received*

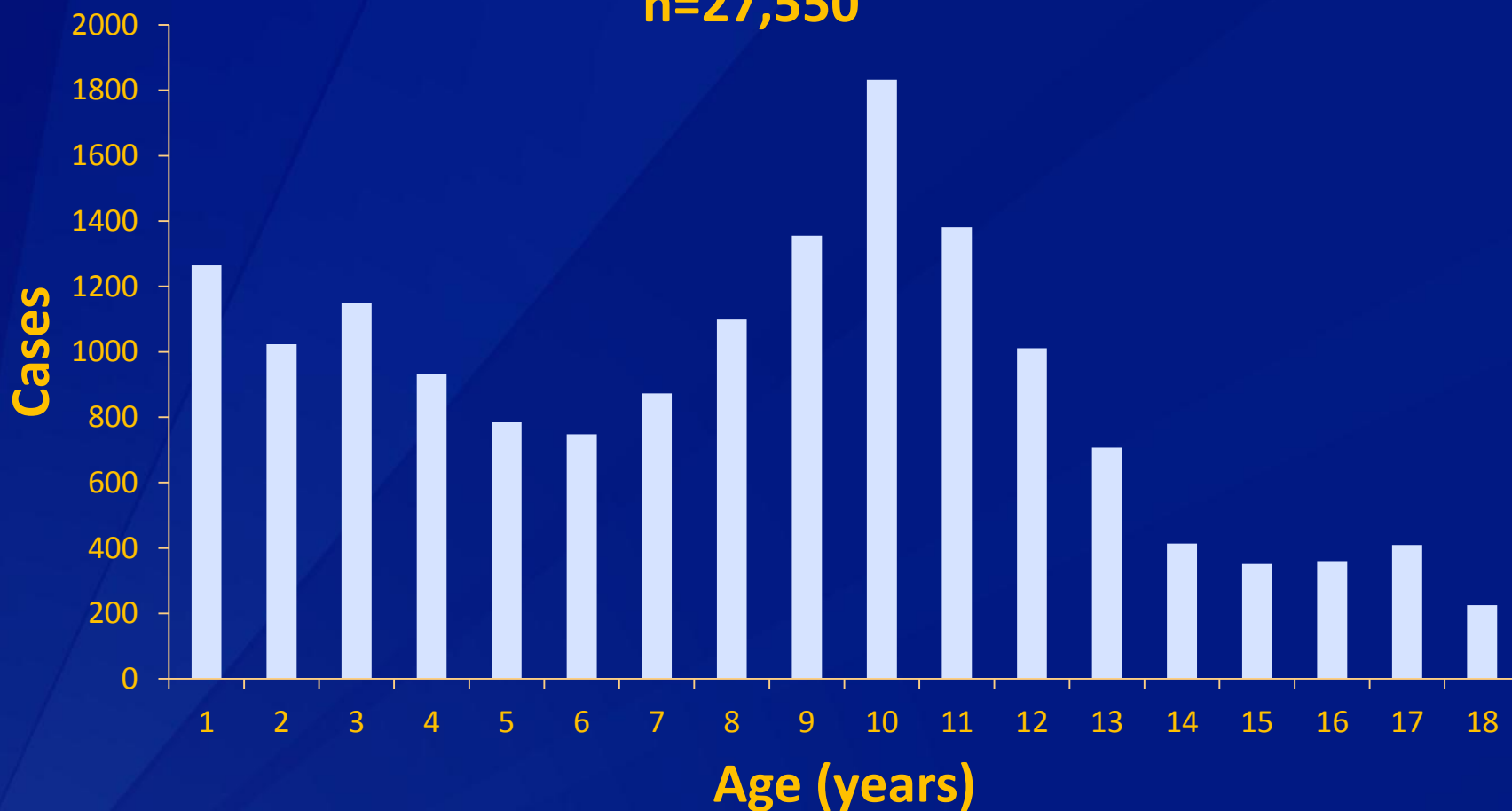
Acellular Only

Transition Period

Whole Cell and Acellular

Pertussis cases by age — United States, 2010

n=27,550



Vaccine
Type
Received*

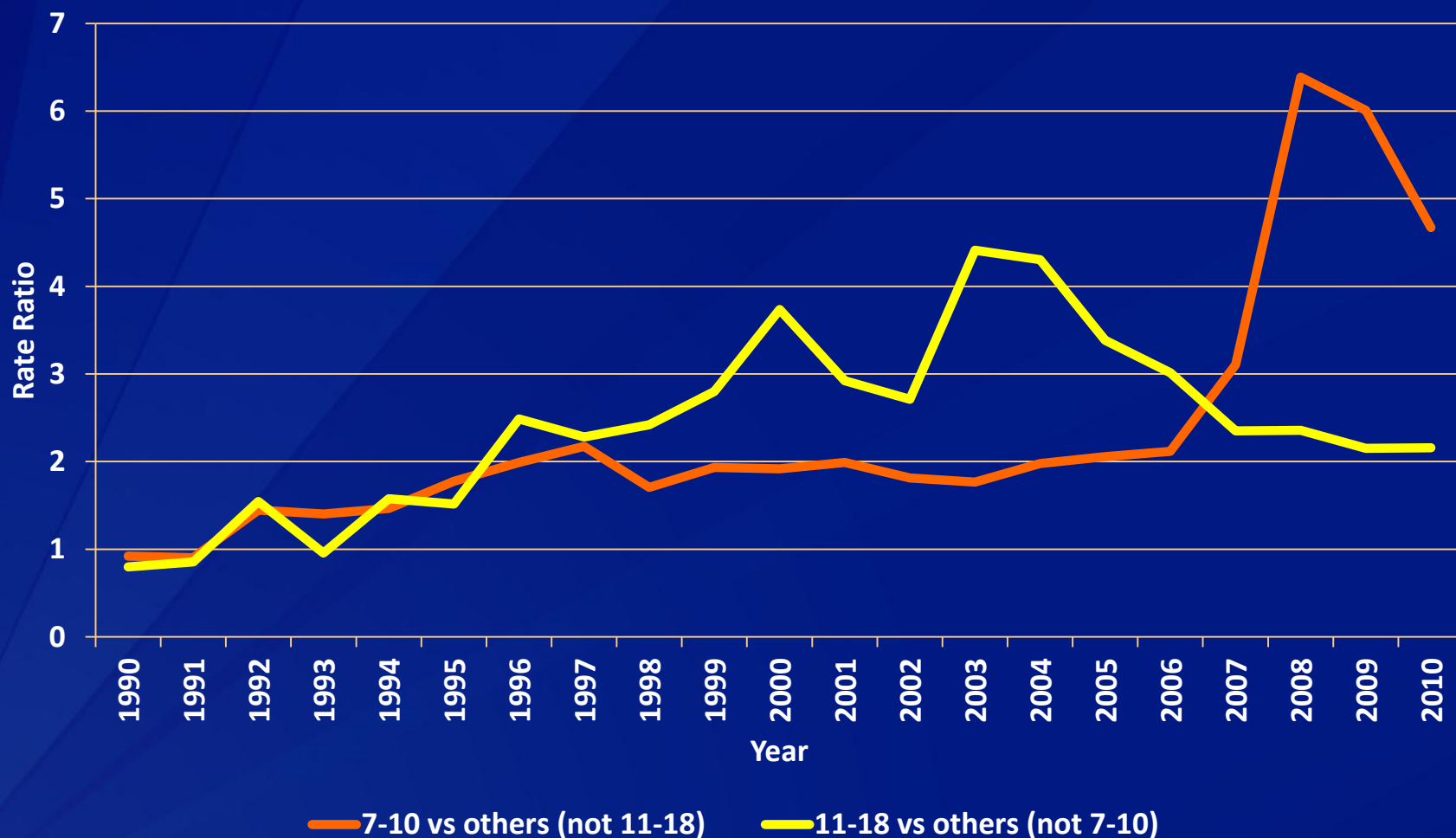
Acellular Only



Whole Cell and Acellular

Transition Period

Incidence rate ratios of pertussis among children 7-10 years and adolescents 11-18 years — 1990–2010



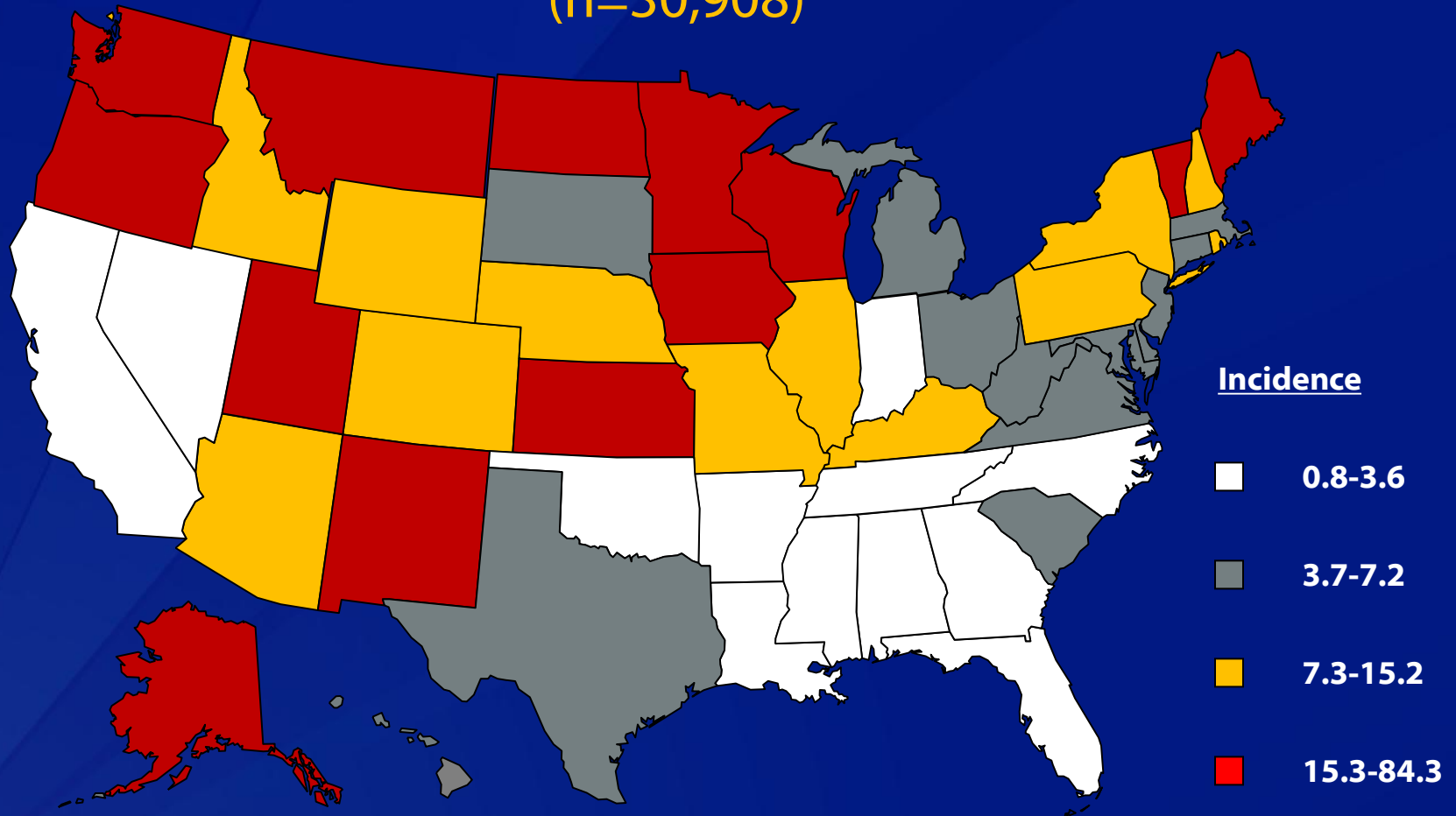
DTaP VE and Duration of Protection Estimates— California, 2010

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

* Accounting for clustering by county and provider

Annual Incidence by State, 2012*

2012 incidence 10.0
(n=30,908)

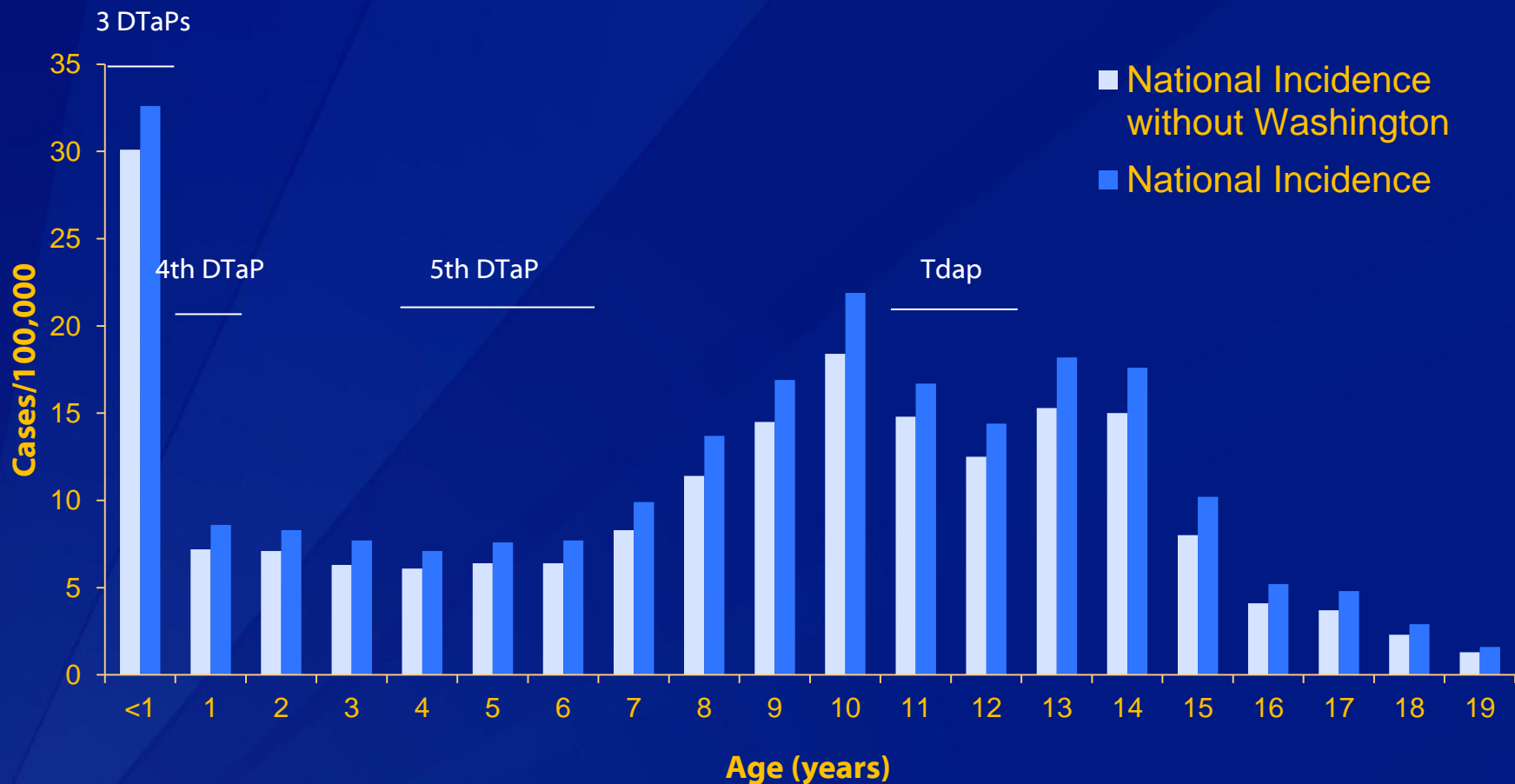


*2012 data are preliminary and subject to change. Data represent cases received at CDC through Week 39.

Source : CDC National Notifiable Disease Surveillance System, 2012

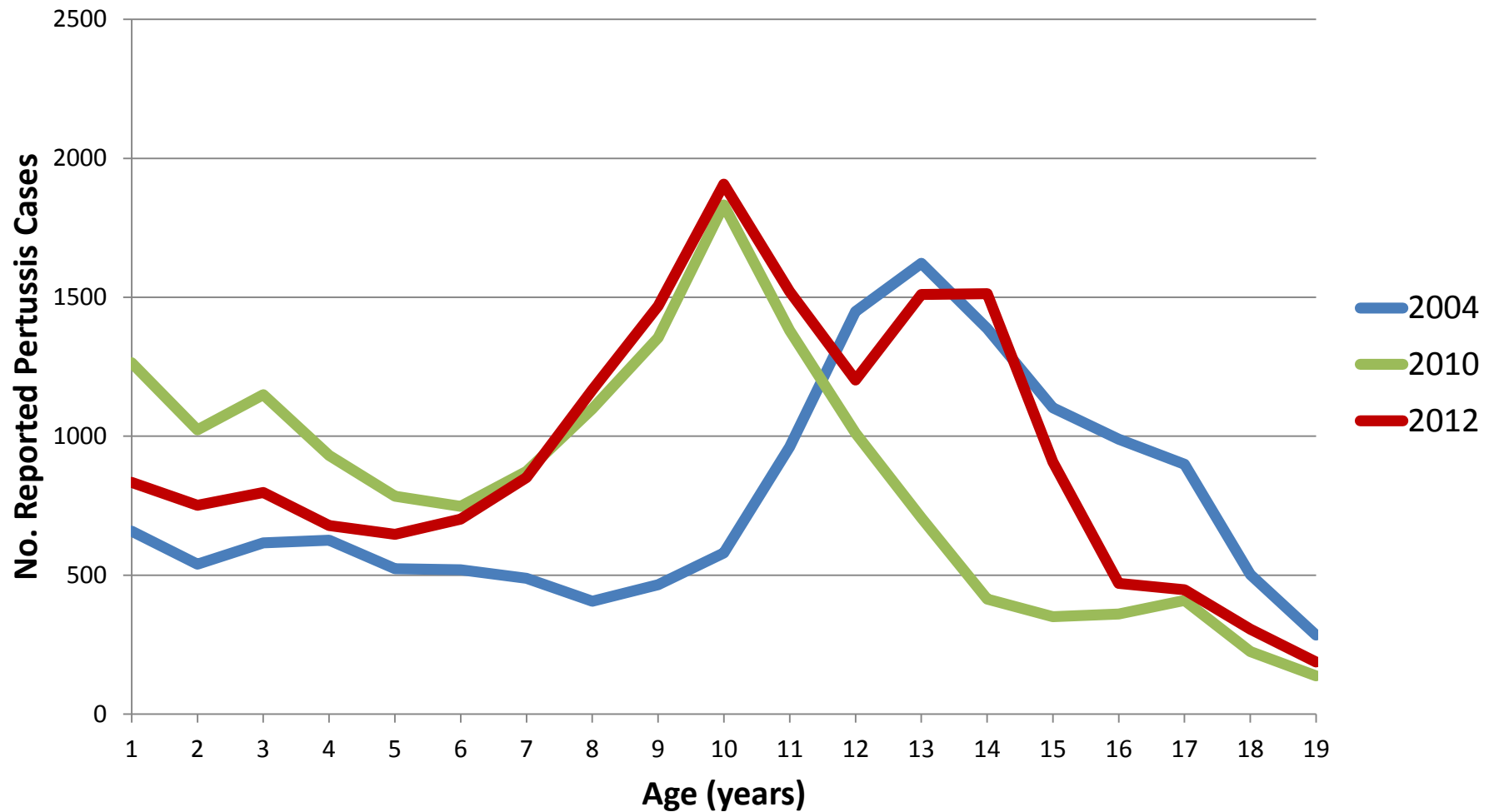
2011 Census data used for population estimates; Incidence is per 100,000 population

Pertussis cases by age — United States, 2012



Vaccine Type Received*	Acellular Only			Transition Period	Whole Cell and Acellular

U.S. Pertussis Cases by Age: 2004, 2010, 2012*



*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, 2}, duration of protection unknown
 - Tdap boost in DTaP recipients may wane more quickly³
- ❑ **Switch to aP vaccines is changing pertussis epidemiology**
 - i.e. a problem of susceptibility *despite* vaccination
 - Waning immunity driving disease incidence

¹Clin Infect Dis. 2010 Aug 1;51(3):315-21.

²Ped Infect Dis J 2009;28(2):152-153.

³CDC. 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

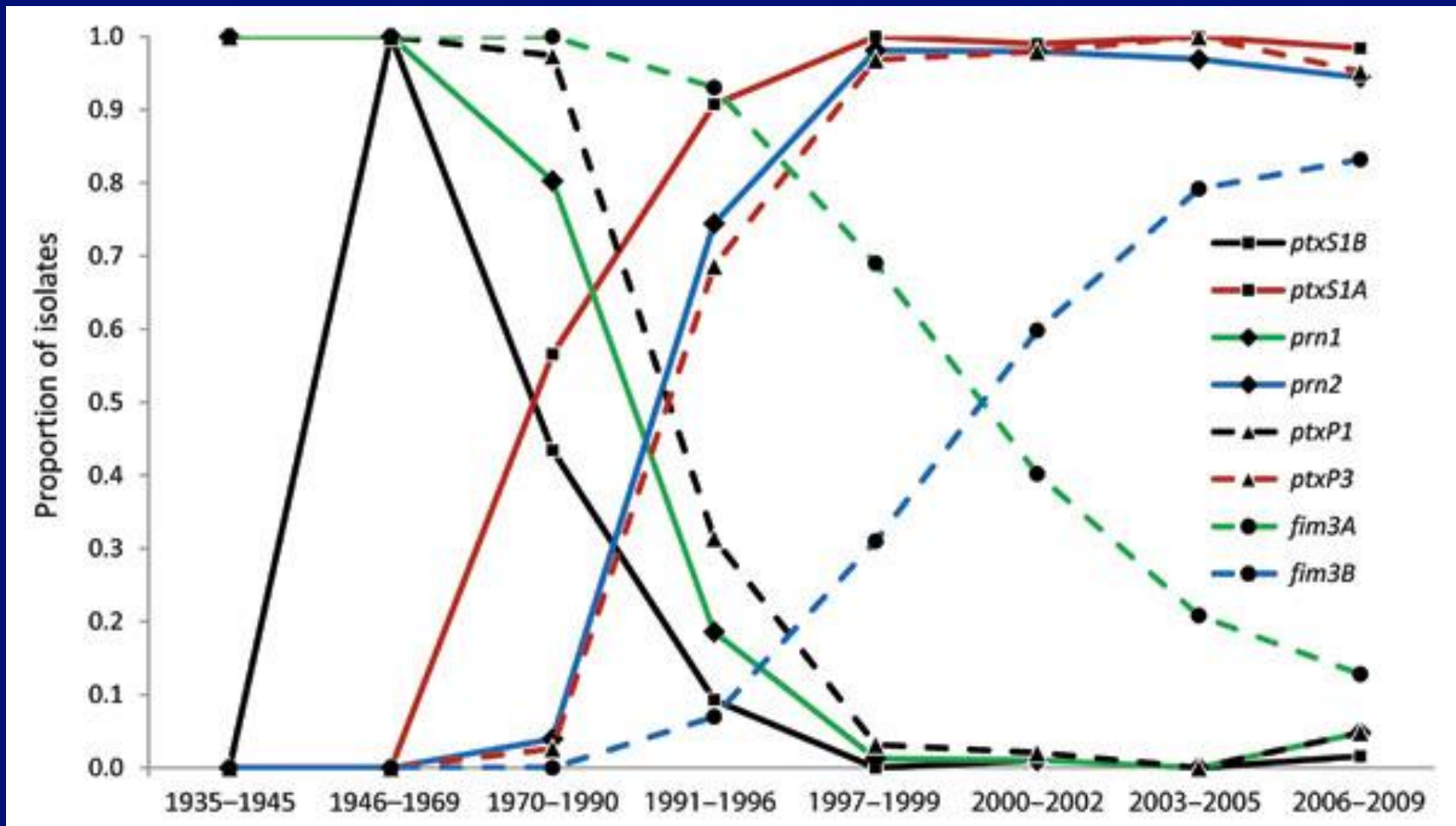
¹Mooi et al. EID 2009;15:1206-1213.

²Clin Microbiol Infect. 2012 Oct;18(10):E377-9. Epub 2012 Aug 22.

³Petersen et al. Emerg Infect Dis 2012; 18: 767–774.

⁴Advani et al. Vaccine 2011; 29: 3438–3442.

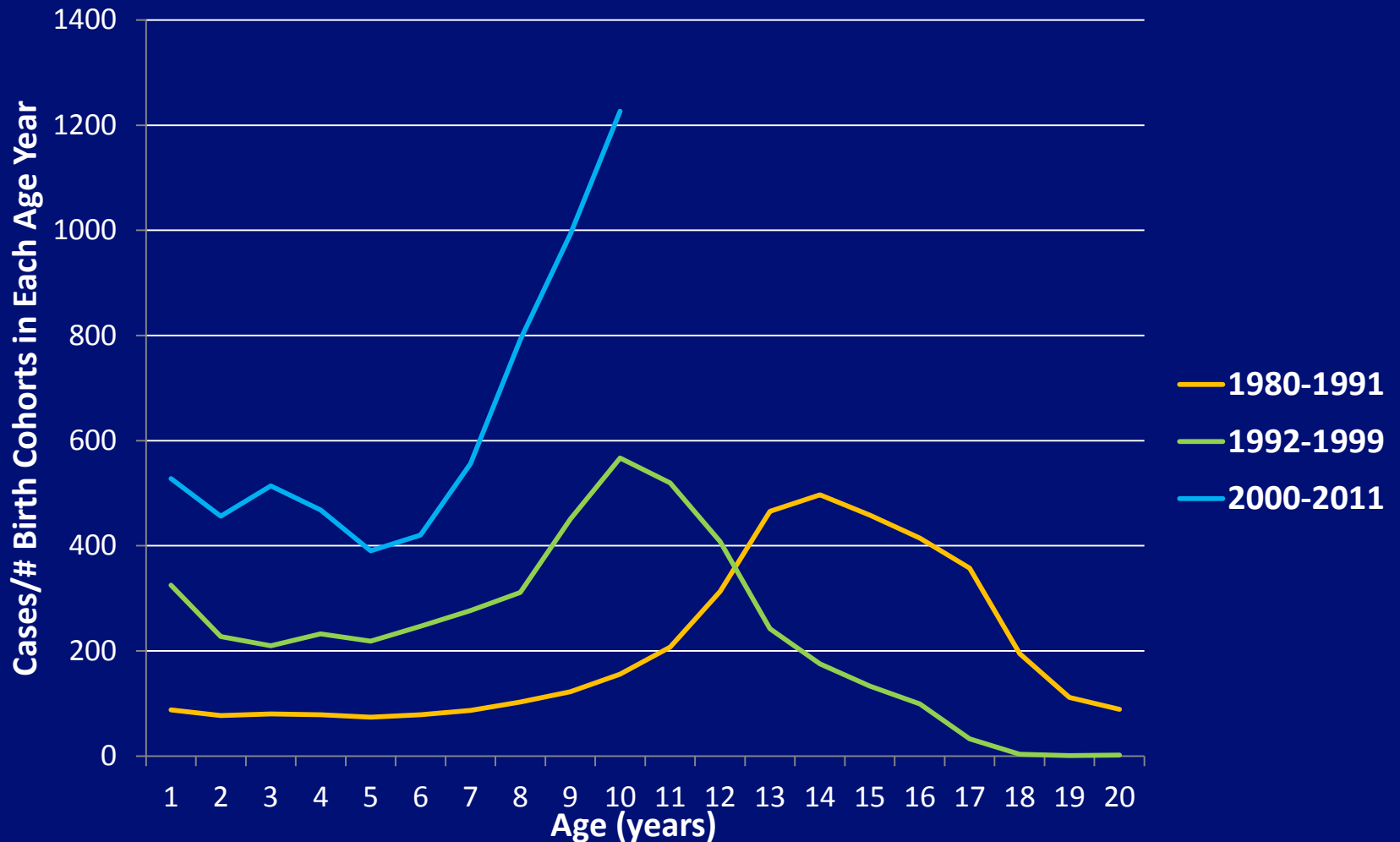
Changes in frequency of dominant vaccine-antigen alleles among *Bordetella pertussis* isolates— US, 1935-2009



Schmidtke AJ, Boney KO, Martin SW, Skoff TH, Tondella ML, Tatti KM. Population diversity among *Bordetella pertussis* isolates, United States, 1935–2009. *Emerg Infect Dis* . 2012 Aug [Cited 15 October 2012].

Waning Immunity by Vaccine Type

Mean Annual Number of Pertussis Cases by Birth Cohort



Maximizing the Vaccination Program

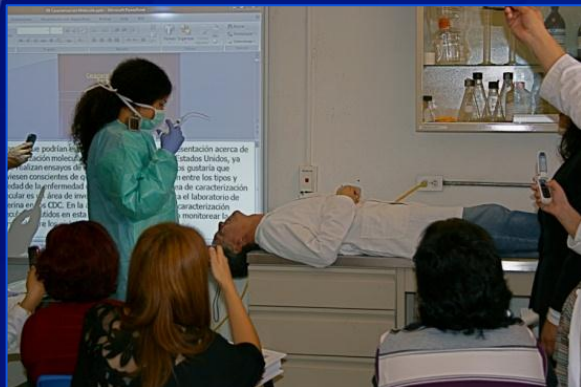


Expanding the Evidence for New Vaccines

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

