

# Pertussis Epidemiology and Vaccination in the United States

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Centers for Disease Control and Prevention

NCIRS Pertussis Meeting

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# **BACKGROUND AND OVERVIEW**

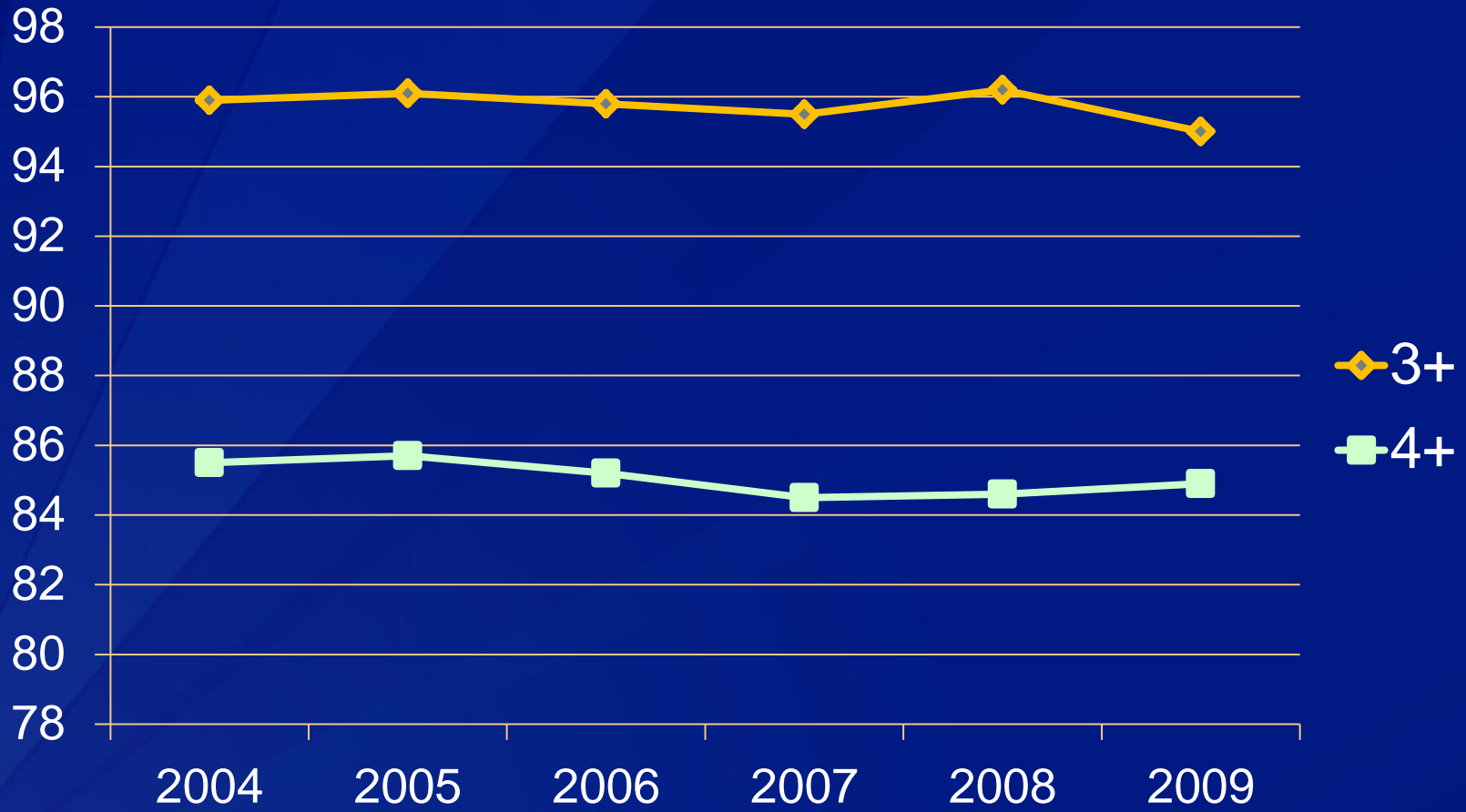
# Pertussis Surveillance and Reporting

- Nationally notifiable
- Clinical (Probable) case
  - Cough  $\geq 2$  weeks AND
  - One among paroxysms, whoop, post-tussive vomiting
- Confirmed case
  - Culture OR
  - Clinical case and PCR positive OR
  - Clinical case and epi-linked to confirmed case

# Pertussis Immunization in the US

- Infants (1997)
  - DTaP at 2, 4, 6 months
- Toddler (1992)
  - DTaP at 15-18 months
- Pre-school (1992)
  - DTaP at 4-6 years
- Adolescent/adult (2005)
  - Single Tdap preferred at 11-12 years

# DTaP coverage among children aged 19 through 35 months



# Reported pertussis cases – 1922-2010

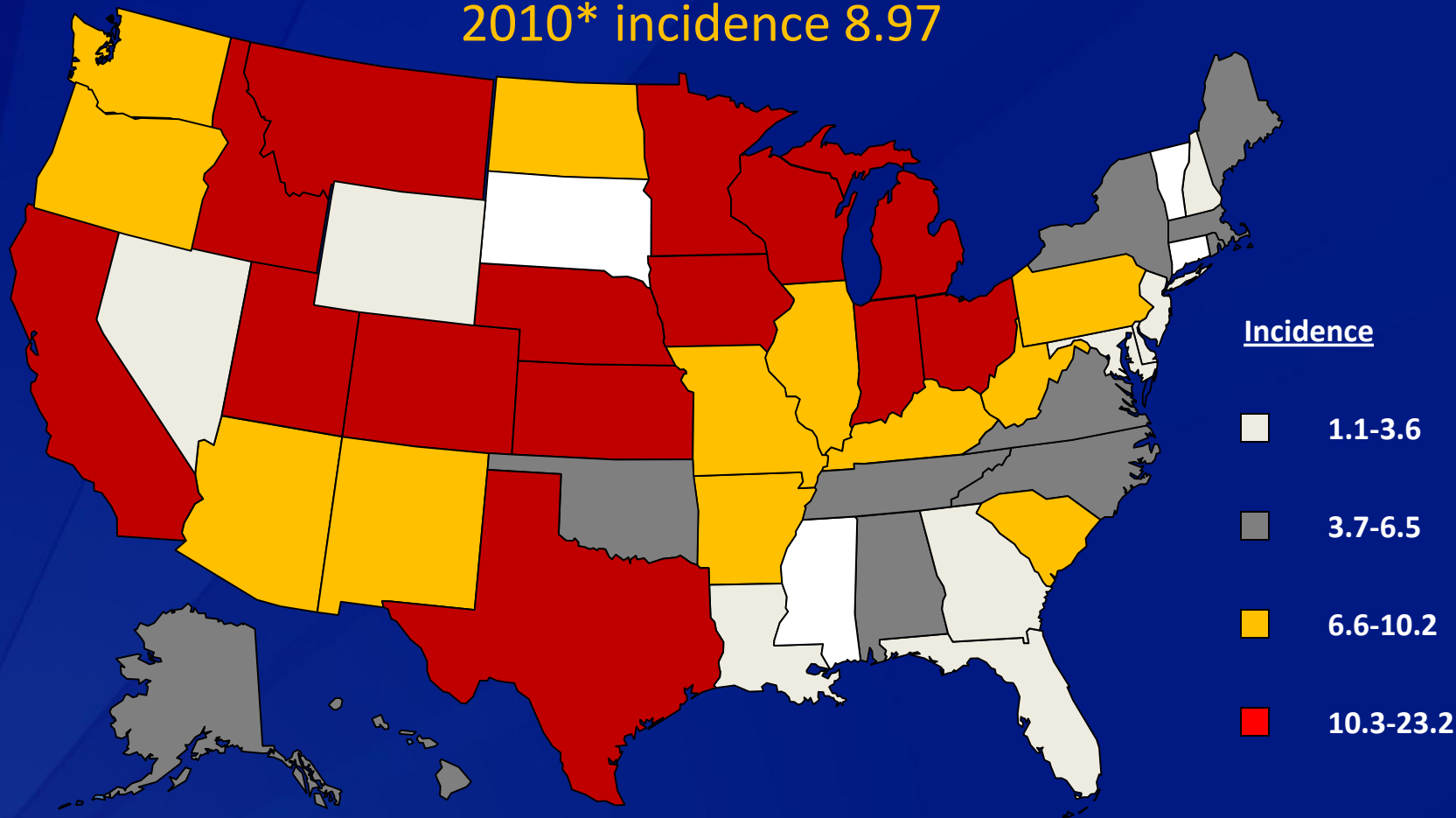


SOURCE: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System and 1922-1949, passive reports to the Public Health Service



# Annual incidence by State, 2010\*

2010\* incidence 8.97



Incidence is per 100,000 population

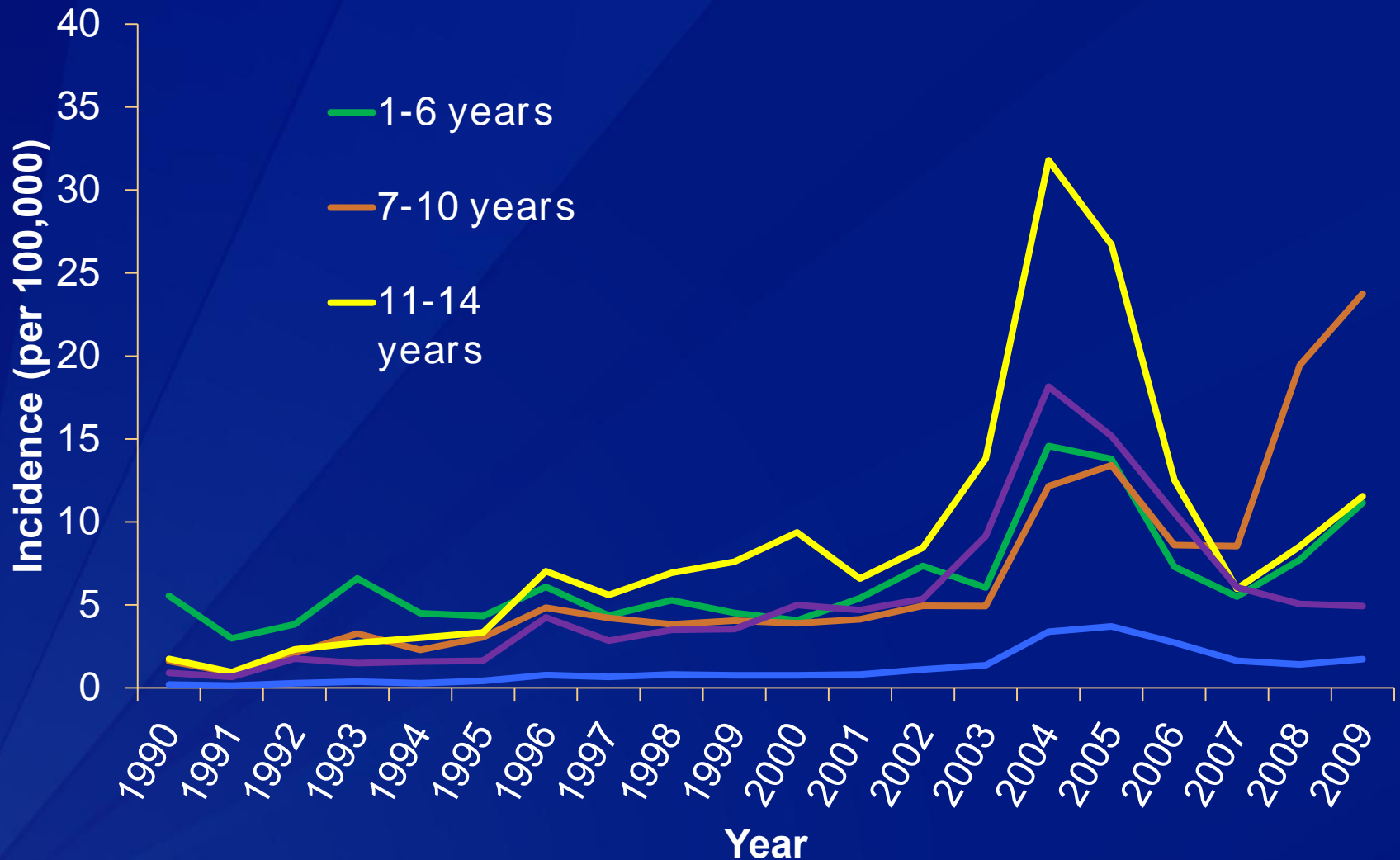
Source : CDC National Notifiable Disease Surveillance System, \*2010 data accessed July 22, 2011

CDC Wonder Population Estimates (Vintage 2009)



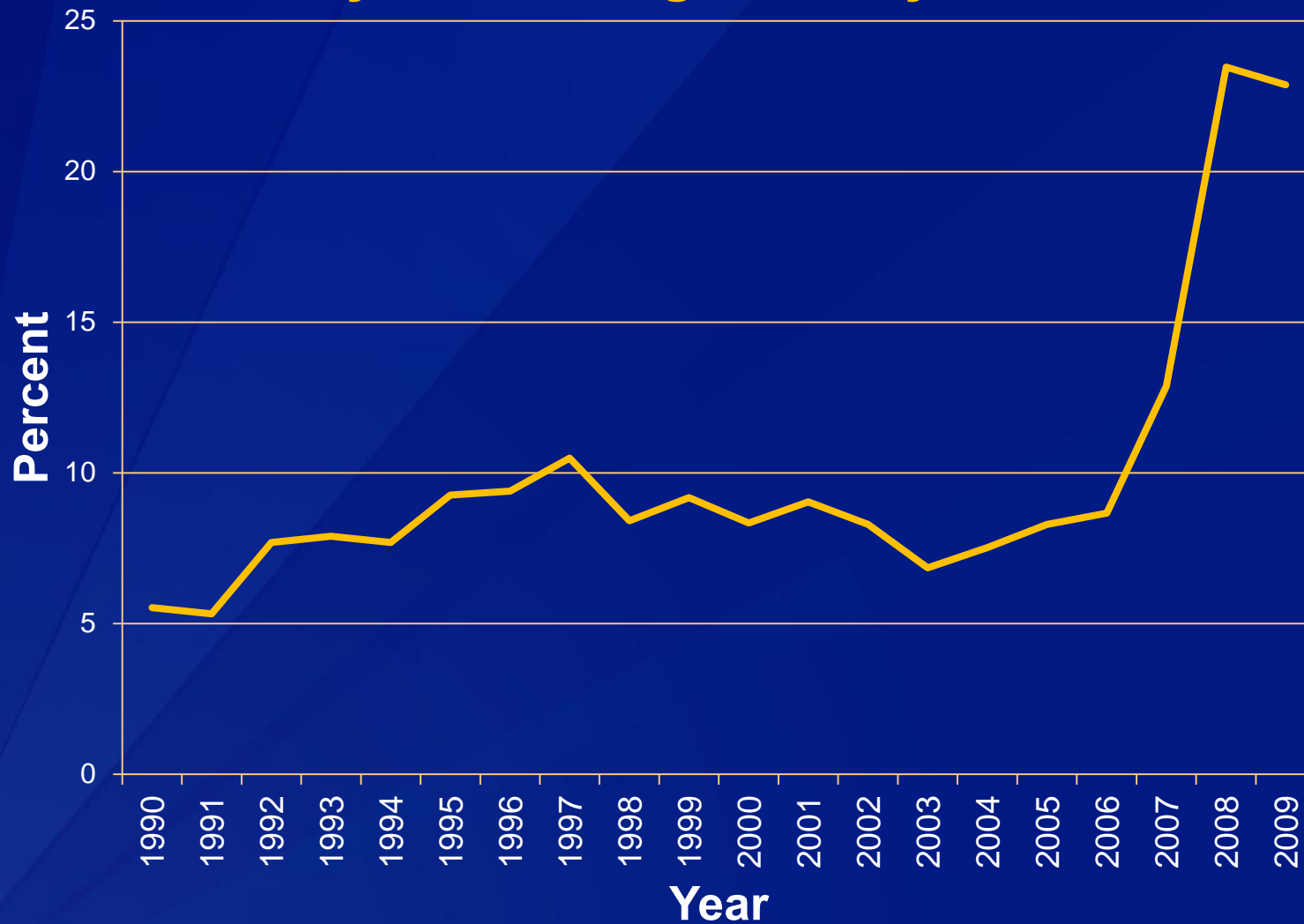
# **EMERGENCE OF DISEASE AMONG 7-10 YEAR-OLDS**

# Pertussis incidence by age group - 1990-2009



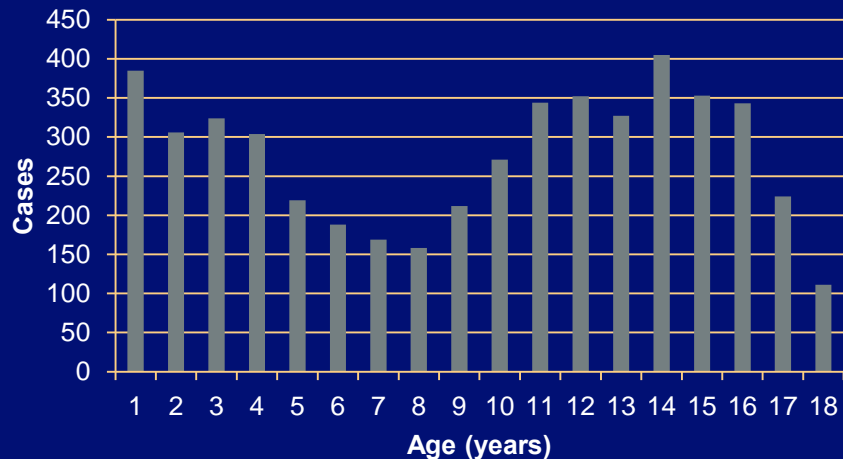
Source: CDC National Notifiable Disease Surveillance System, 2009  
CDC Wonder Population Estimates (Vintage 2009)

# Proportion of all pertussis cases contributed by children aged 7-10 years

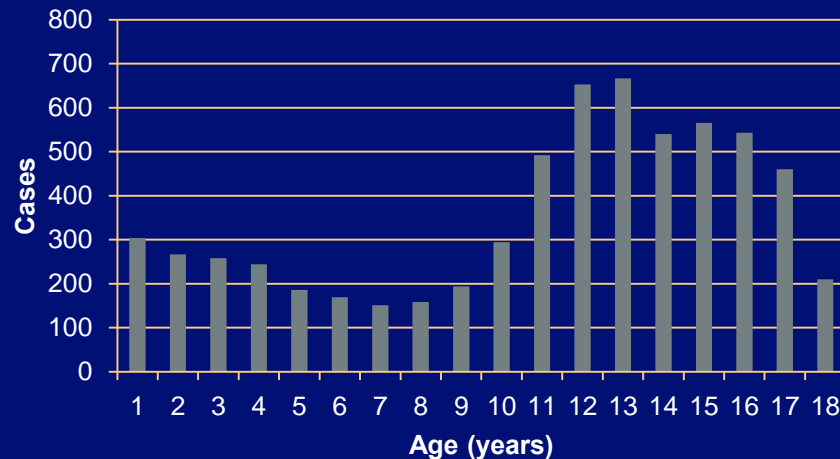


# Pertussis cases by age – 2002-2005

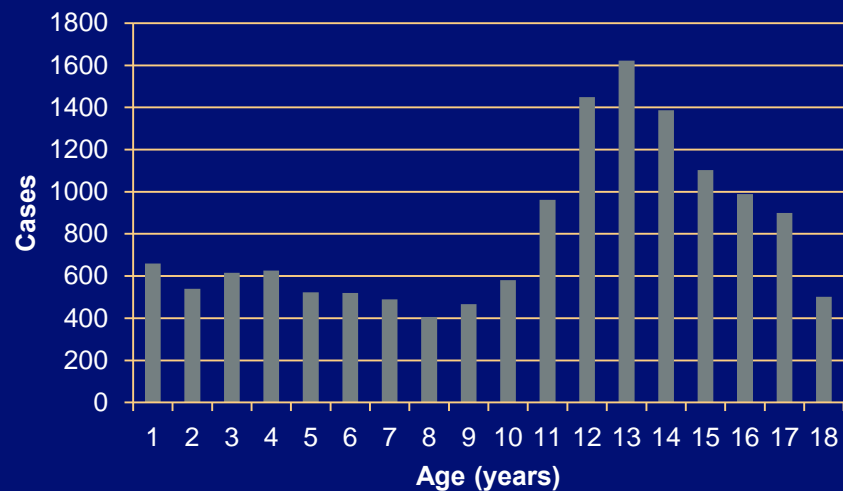
2002



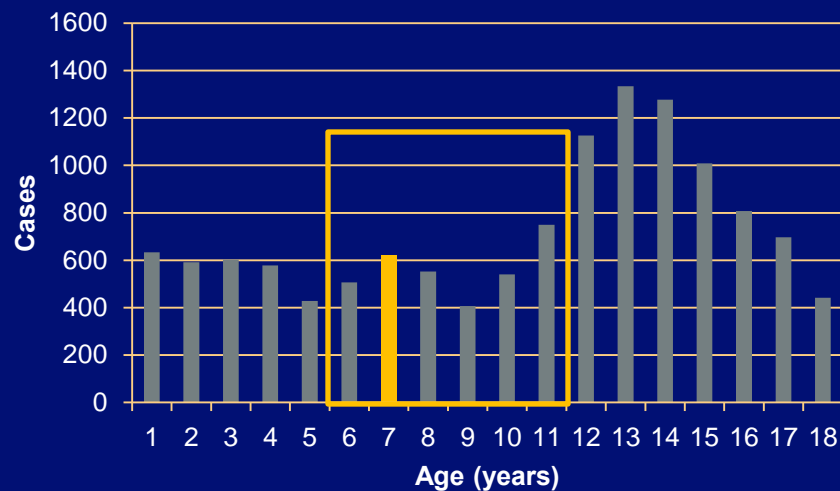
2003



2004

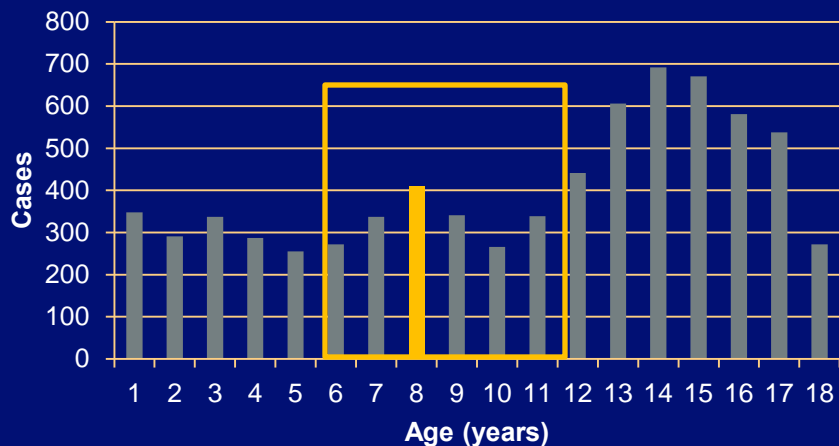


2005

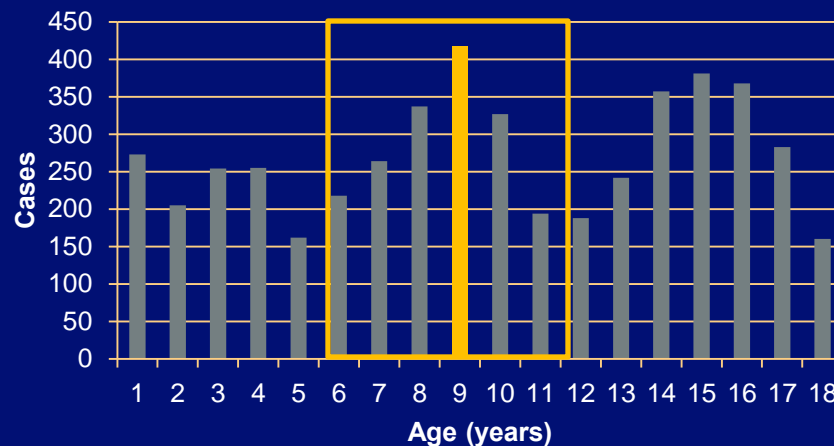


# Pertussis cases by age – 2006-2009

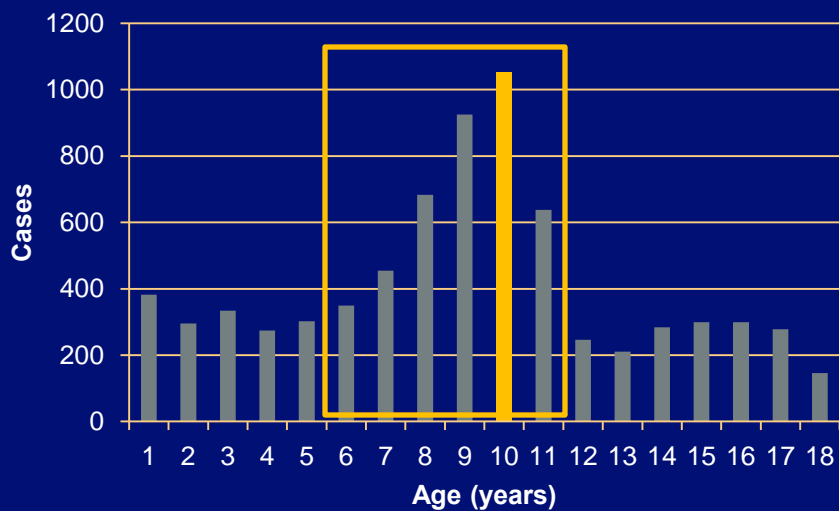
## 2006



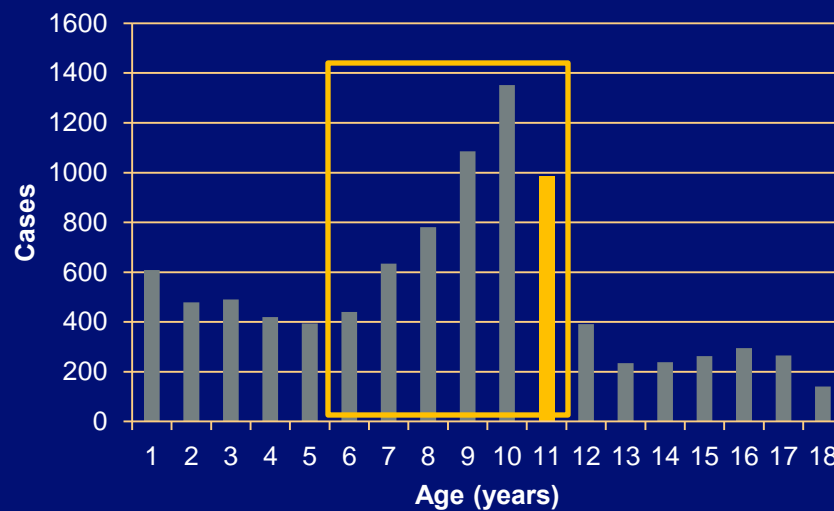
## 2007



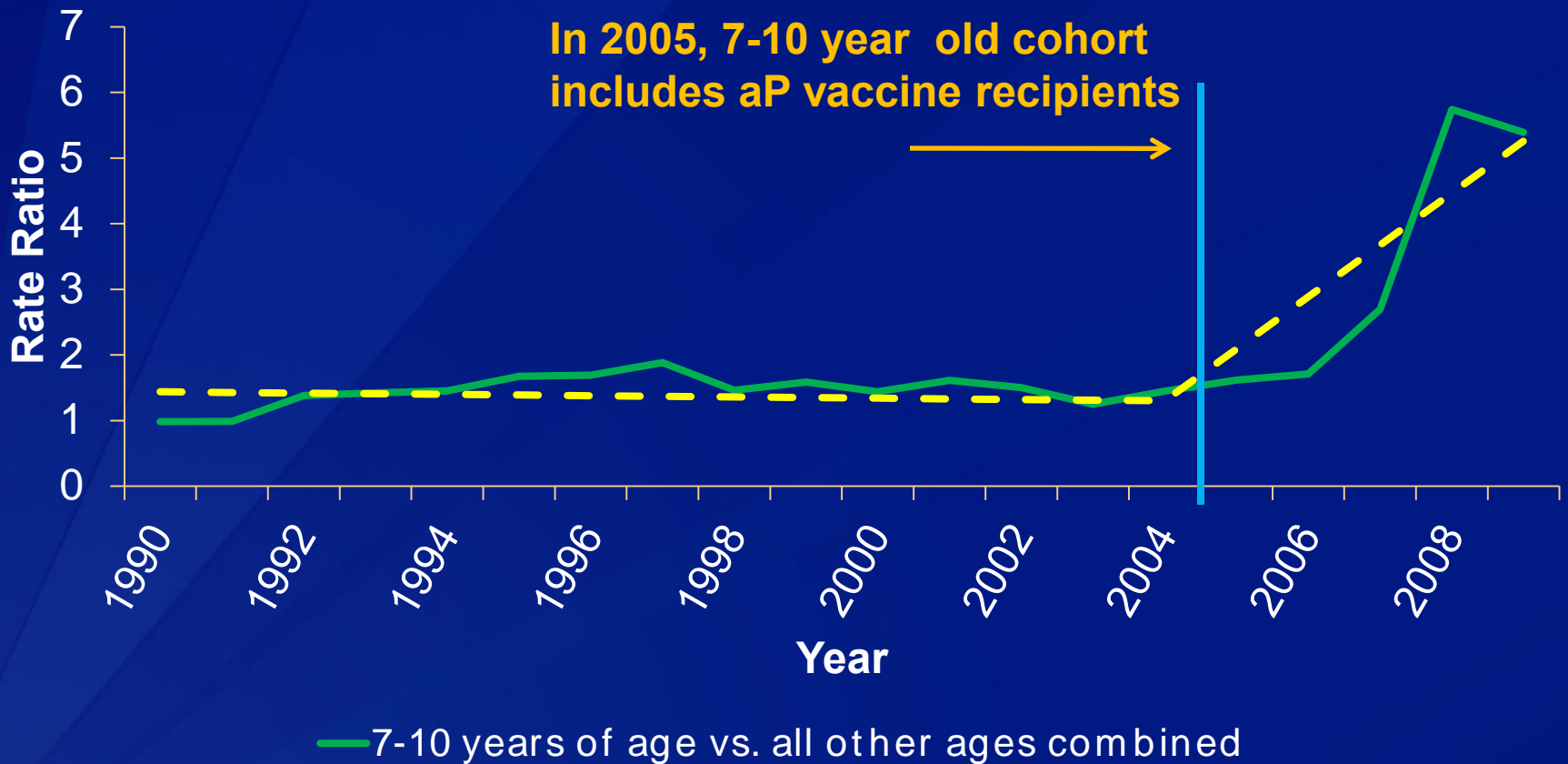
## 2008



## 2009

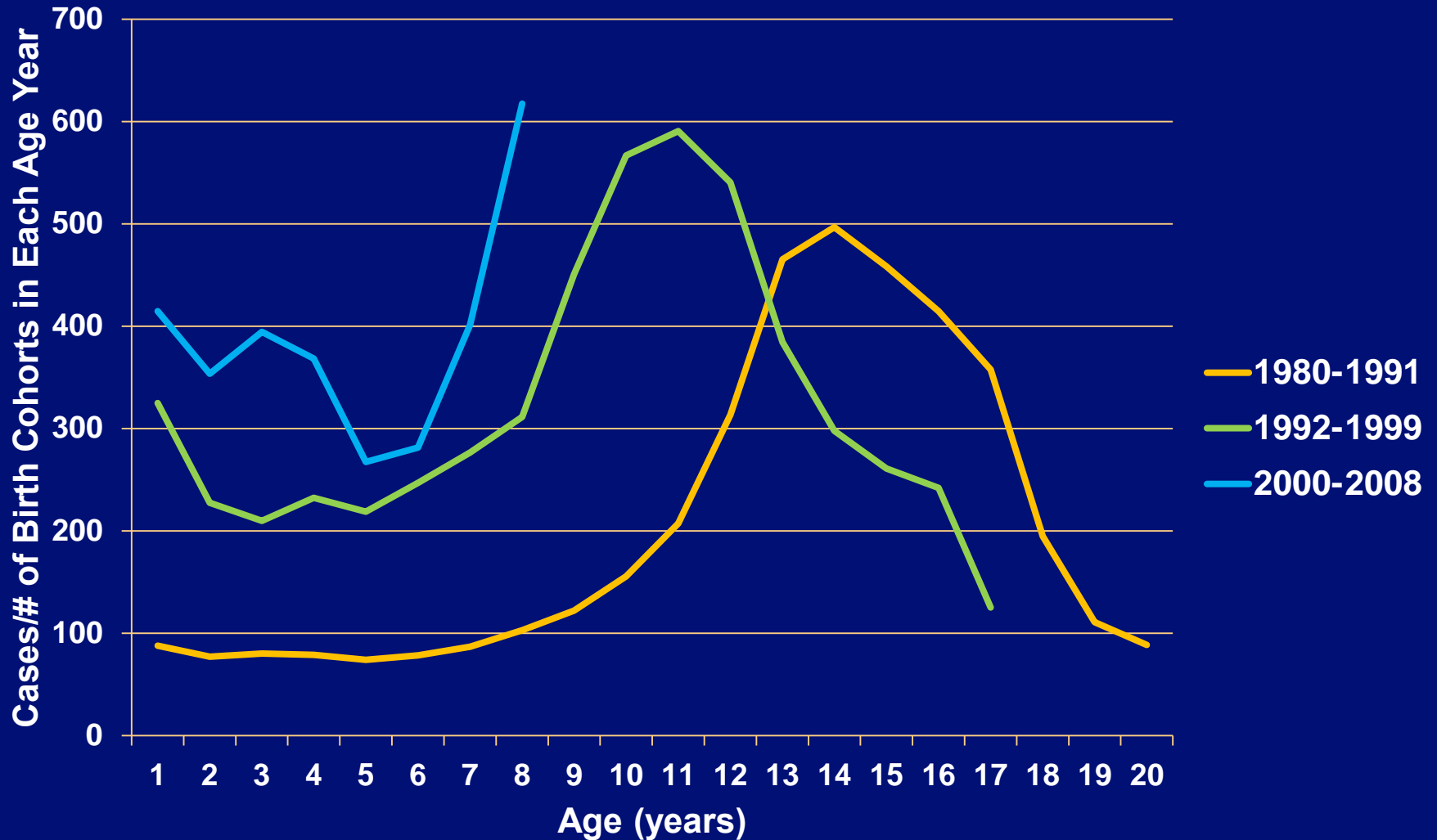


# Incidence rate ratios of pertussis among children aged 7-10 years – 1990-2009



# Waning Immunity by Vaccine Type

## Mean Annual Pertussis Cases by Birth Cohort



# Ongoing Evaluations of DTaP Series

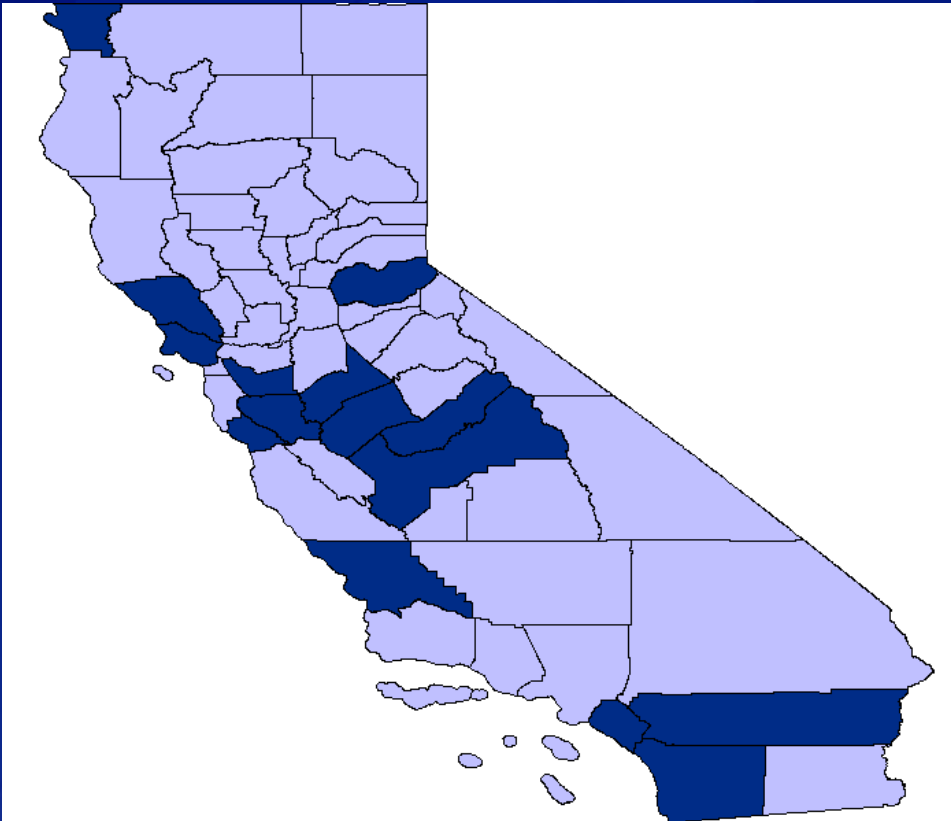
- ❑ **California DTaP Vaccine Effectiveness Assessment**
  - Case-control design using provider-verified immunization data
- ❑ **Registry Assessment: Duration of Protection**
  - Mergers of immunization registries and surveillance databases

# CDPH / CDC Pertussis VE Assessment

## Primary Objectives:

- ❑ Assess overall VE of DTaP following the complete childhood series
- ❑ Determine duration of protection by assessing VE at specific time points post vaccination

# CA VE Assessment Participating Counties



Alameda

Del Norte

El Dorado

Fresno

Madera

Marin

Merced

Orange

Riverside

San Diego

San Luis Obispo

Santa Cruz

Santa Clara

Sonoma

Stanislaus

## CA VE Case Control Design

- ❑ Cases & controls 4-10 yrs at illness onset or enrollment
- ❑ Reported pertussis cases in 15 CA counties
- ❑ Unmatched controls, from case-patient providers (3:1)
- ❑ In-person collection of vaccine history data
- ❑ Analysis: logistic regression, adjusted for cluster sample design

# CDPH Case Definition for Pertussis

- Clinical case definition: Cough  $\geq 2$  weeks AND paroxysms, inspiratory whoop, or posttussive vomiting

Confirmed (47.6%)	<ul style="list-style-type: none"><li>- Culture positive + cough any duration</li><li>- PCR positive + clinical case definition</li><li>- Epi-Link + clinical case definition</li></ul>
Probable (8.3%)	<ul style="list-style-type: none"><li>- Meets clinical case definition</li></ul>
Suspect (23.5%)	<ul style="list-style-type: none"><li>- PCR confirmed + cough any duration</li><li>- Epi-Link + cough any duration + other symptom</li></ul>

\* Status pending (19.0%) or Missing (1.7%)

# Interim Results

## CA VE Timing of 5<sup>th</sup> Dose

	Case (%)	Control (%)	P-Value
Received 5 DTaP doses			
Yes	668 (69.2)	2151 (75.5)	< 0.001
Age at 5 <sup>th</sup> Dose			
4	436 (65.2)	1456 (67.7)	0.07
5	204 (30.5)	594 (27.6)	
6	6 (0.9)	20 (0.9)	
7+	8 (1.2)	13 (0.6)	
Missing	14 (2.1)	68 (3.2)	

# CA VE Interim Analysis \*

## Overall VE Estimates

Model **	Case (n)	Control (n)	VE, %	95% CI
Overall VE, All Ages				
0 dose	53	24	Ref	--
5 doses	668	2151	85.9	75.6 - 91.9
Overall VE, All Ages				
0 dose	53	24	Ref	--
4 doses, 4 <sup>th</sup> dose after age 4	32	74	80.4	62.5 - 89.8

\* VE estimates are preliminary and based on interim data.

\*\* Adjusted for County and provider clustering.

# CA VE Interim Analysis \*

## Time Since 5<sup>th</sup> Dose VE Estimates

Model **	Case (n)	Control (n)	VE, %	95% CI
Time since 5 <sup>th</sup> dose				
0 doses	53	24	Ref	--
< 12 months	56	458	94.5	90.5 – 96.8
12 – 23 months	55	403	93.8	90.1 – 96.2
24 – 35 months	76	375	90.8	84.3 – 94.6
36 – 47 months	108	303	83.9	72.9 – 90.4
48 – 59 months	141	290	78.0	59.9 – 87.9
60+ months	220	322	69.1	43.0 – 83.2

\* VE estimates are preliminary and based on interim data.

\*\* Adjusted for County and provider clustering.

## Registry Assessment: Objective

- ❑ Investigate waning of immunity in the five years post 5<sup>th</sup> DTaP dose through evaluation of incidence rates and risk of pertussis.

# Registry Assessment: Data Sources

## Statewide Pertussis Surveillance (NNDSS)

- Jan 1, 1998 – Oct 31, 2010
- Confirmed & probable cases

## Immunization Registry

- Birth cohorts 1998 – 2003
- 5 DTaP doses
- 5<sup>th</sup> dose between 4-6 years

Linkage

## Population to date

- Minnesota cohort
- 353 cases
- Total N=199,643

# Registry Assessment: Cohort Analyses

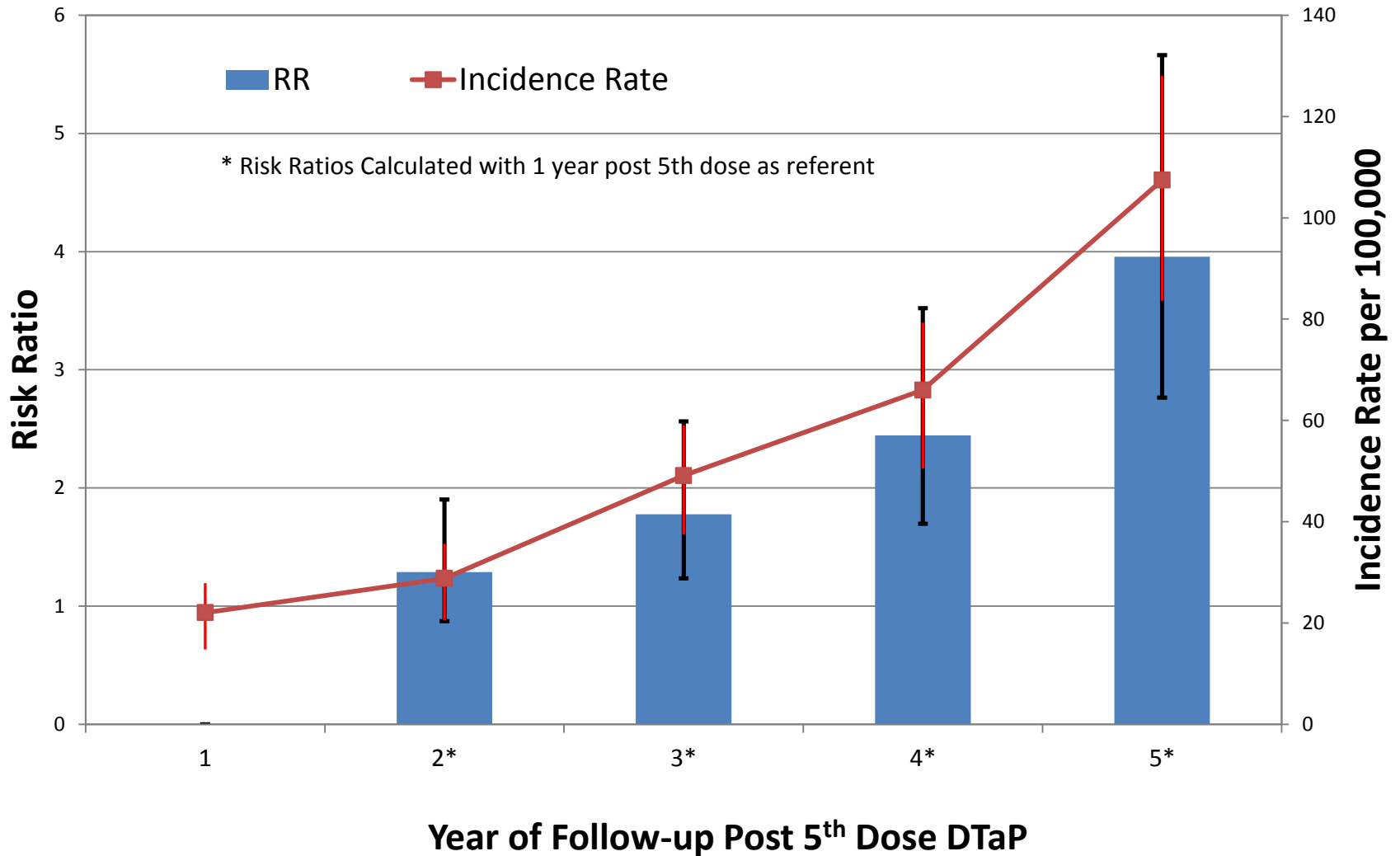
## □ Incidence rates

- Incidence rates of pertussis for each year following the 5<sup>th</sup> DTaP dose (up to 5 years time-since)

## □ Risk

- Risk ratios calculated using longitudinal modeling
- 1 year post-vaccination referent group
- Adjusts for repeated measures correlation structures

# Preliminary Risk Ratios and Incidence Rates for Pertussis by Year of Follow-up post 5<sup>th</sup> Dose DTaP - Minnesota 2010



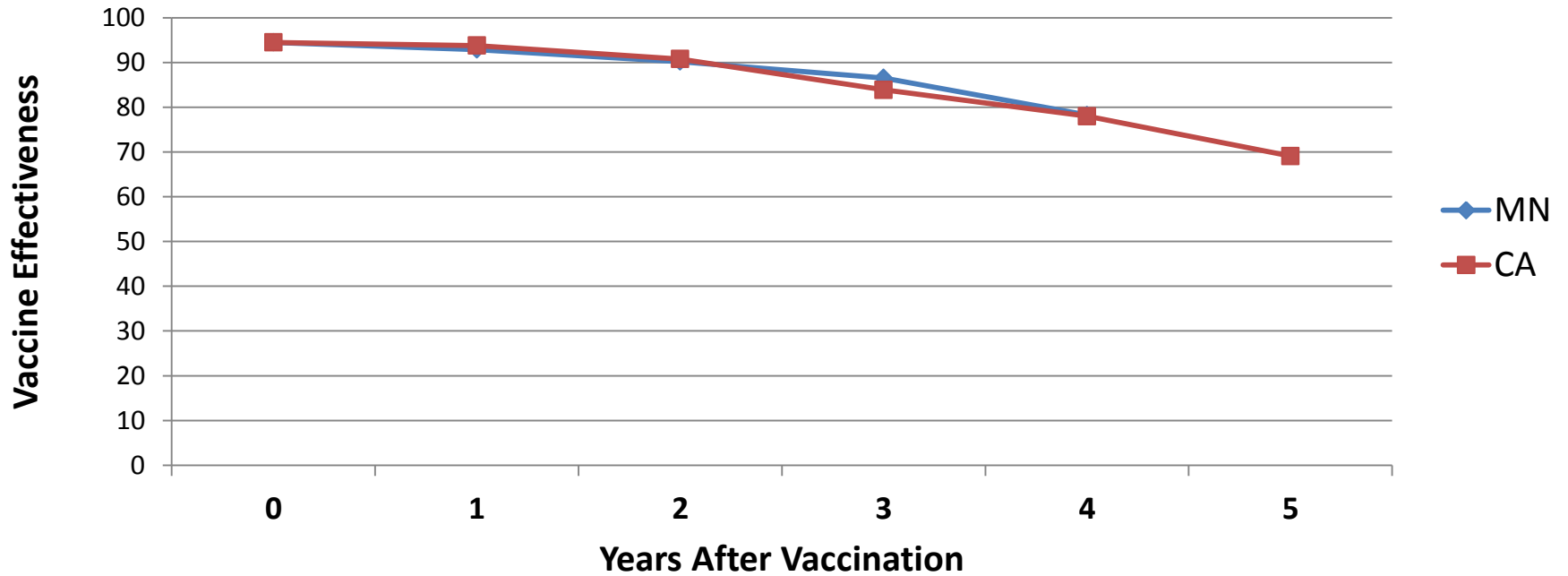
## Relationship between CA VE Estimates and MN Estimates of Risk

Time (months)	CA VE (%)	Vaccinated Susceptibles (N) *	VS Ratio	MN Model RR	Predicted Cases (N) **
<12	94.5	3,850	Ref	Ref	18
12 – 23	93.8	4,340	1.13	1.29	24
24 - 35	90.8	6,440	1.67	1.78	33
36 - 47	83.9	11,270	2.93	2.44	45
48 - 59	78.0	15,400	4.00	3.95	72
60 +	69.1	21,630	5.62	--	--

\* Based on birth cohort size of 70,000

\*\* Based on birth cohort size of 70,000 and MN model

## DTaP Waning Each Year After Vaccination



		# Susceptibles *	VE	
Year post-vaccination	MN RR	MN	MN	CA
0		5.5	94.5	94.5
1	1.29	7.1	92.9	93.8
2	1.78	9.8	90.2	90.8
3	2.44	13.4	86.6	83.9
4	3.95	21.7	78.3	78
				69.1

\*Based on cohort size = 100

## **Summary and Future Directions**

- ❑ Modest waning of immunity contributing to emergence of pertussis among school-aged children**
- ❑ Completing observational and modeling assessments of factors contributing to pertussis resurgence**
- ❑ Expanding and maximizing benefits of immunization program**
- ❑ Assessing immunology/vaccinology**

# Thank You

**For more information please contact Centers for Disease Control and Prevention**

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Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348

E-mail: [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov) Web: [www.cdc.gov](http://www.cdc.gov)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

National Center for Immunization & Respiratory Diseases

Meningitis and Vaccine Preventable Diseases/Division of Bacterial Diseases





# Reported pertussis-related deaths by age-groups - 1980-2009\*

Age-Group	1980-1989 <sup>1</sup>	1990-1999 <sup>1</sup>	2000-2009 <sup>2</sup>
0-1 month	38	68	119
2-3 month	11	16	56
4-5 month	5	5	6
6-11 month	7	4	1
1-4 years	13	2	2
5-10 years	1	6	2
11-18 years	0	0	2
>18 years	1	2	6
Total	77 <sup>†</sup>	103	195*

See Poster #94

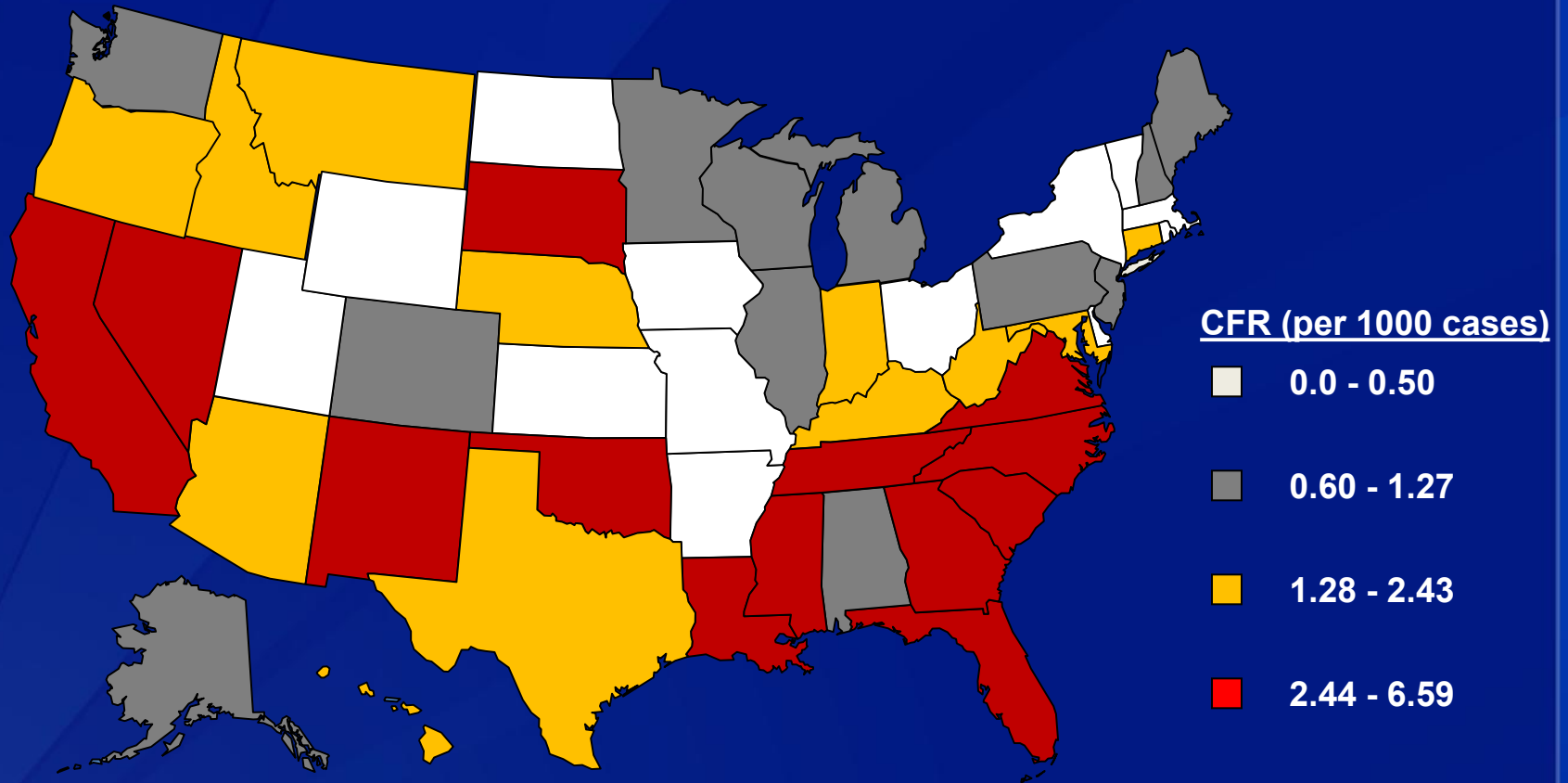
\*2009 Data are provisional

<sup>1</sup> Vitek CR et al. *Pediatr Infect Dis J* 2003; 22(7):628-34.

<sup>2</sup> National Notifiable Diseases Surveillance System, CDC, 2009\*

<sup>†</sup> Includes one case with unknown age

# Average Pertussis Case Fatality Rate, by State 2000 - 2010



Source : CDC National Notifiable Disease Surveillance System, through 2010 provisional data.



# **PREVENTION AND EVALUATION**

# Popular Press

**Whooping Cough Claims 3rd Life in L.A. County, Disease Now Considered an Epidemic in California**

With around 1,500 cases this year -- that's the highest more than last year -- California health officials have declared the rise of whooping cough, officially known as pertussis, an epidemic. "We are facing what could be the worst case for pertussis in California in about 40 years," CDC Director, Thomas Frieden said in a press conference.

# Vaccine Clinics

## Hundreds Show Up For Free Whooping Cough Shots



# Provider Outreach

**Are you looking for MATERIALS to educate parents about pre-teen vaccines and the 11 and 12 year old check-up?**

**CDC Commentary: With Pertussis on the Rise, Who Needs a Tdap Vaccination?**  
Stacey W. Martin, MSc  
Authors and Disclosures  
Posted: 07/02/2010

**RELATED ARTICLES**

- Recommended Childhood Vaccines Safe for Children With Inborn Errors of Metabolism
- Neonatal Vaccination: A Once in a Lifetime Opportunity

# Digital Media

**Coughing?**  
Could it be Pertussis (Whooping Cough)?

- Tobacco Controls
- NHTD 2010
- Refugee Health
- Pertussis
- Gulf Oil Spill

**Whooping cough: Teens & adults can get the disease and spread it to babies. Get a Tdap booster shot**  
<http://is.gd/d8TyK>



**Clinician Outreach and Communication Activity (COCA)**

Our goal is to help clinicians offer optimal care to patients by providing them with the most current and reliable information available on emerging health threats.

**News & Highlights**

- Gulf of Mexico Oil Spill
- Gulf Oil Spill Clinical Guidance

**Upcoming Call**

**About COCA**  
The CDC Emergency Communication System's Clinician Communication Team manages the Clinician Outreach Communication Activity (COCA) to ensure that clinicians have the up-to-date information they need... More

Don't risk spreading whooping cough to your infant.

Create a circle of protection – get vaccinated.

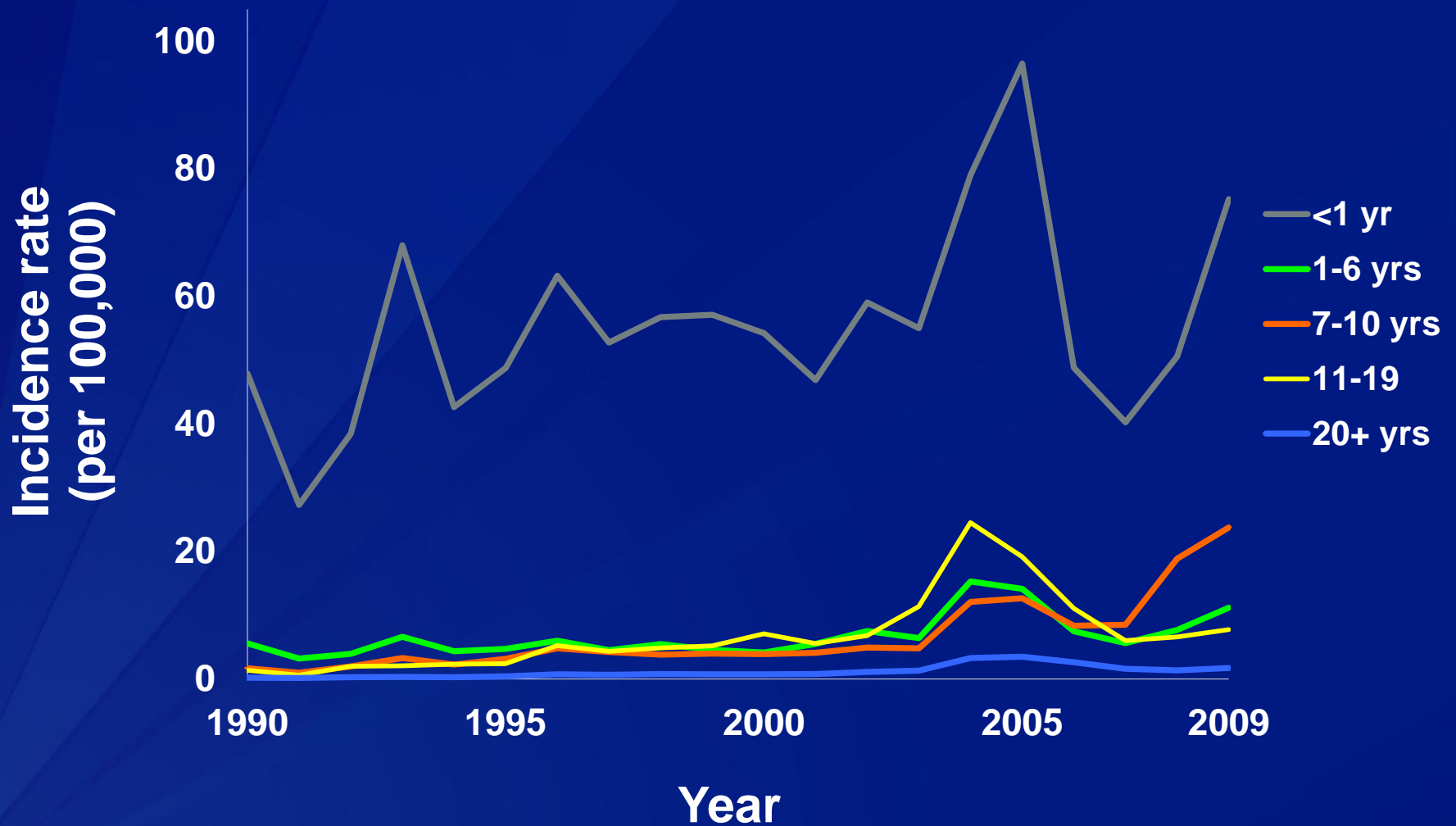


**Promoting “cocooning” to protect infants**

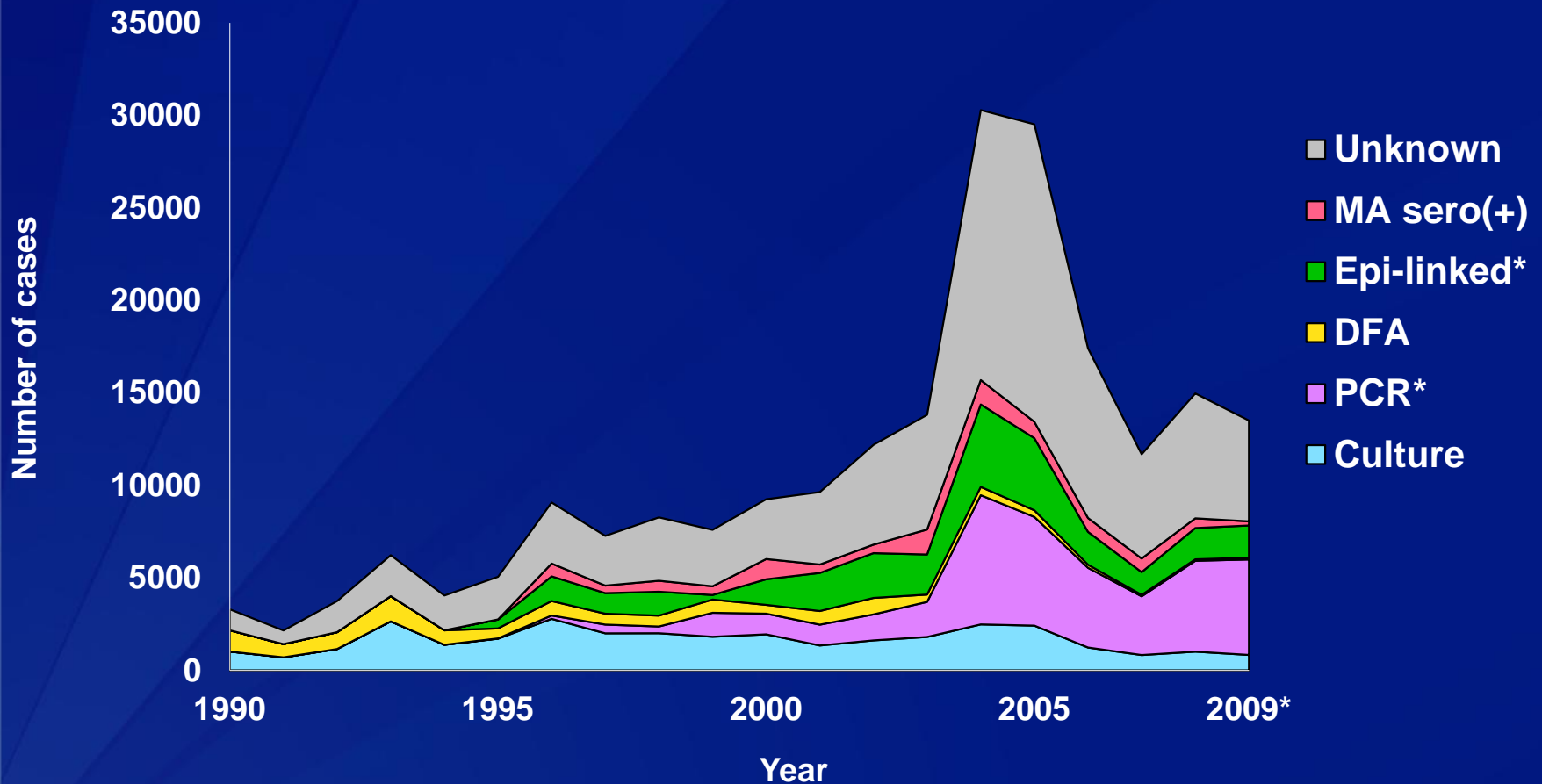


**ACIP considering expanded  
recommendations (poster 81)**

# Reported pertussis incidence by age group - 1990-2009



# Number of reported pertussis cases by diagnosis\* - 1990 – 2009\*\*



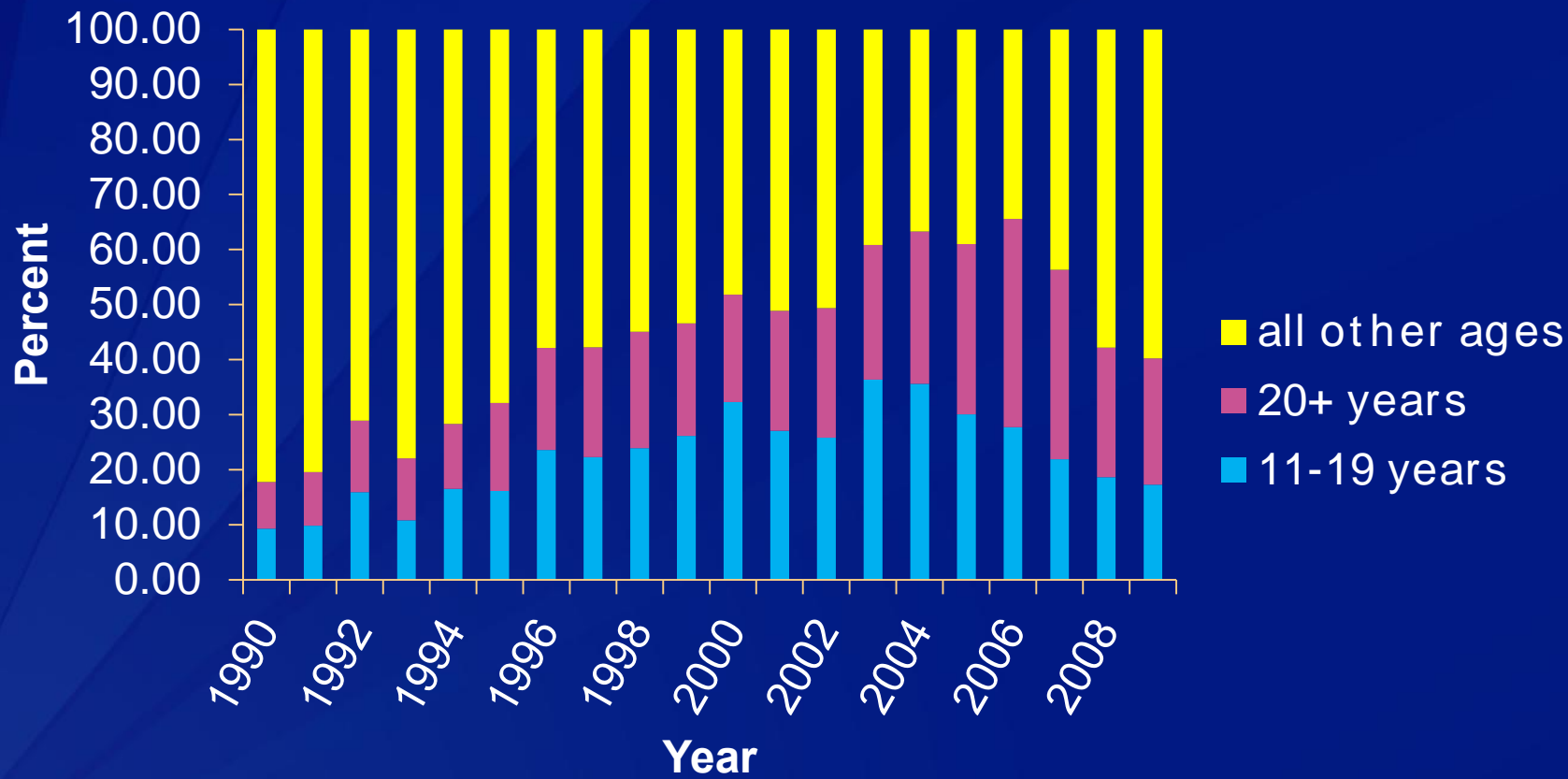
See Posters 91 - 93

\*Data collection for PCR and epi-link began in 1995.

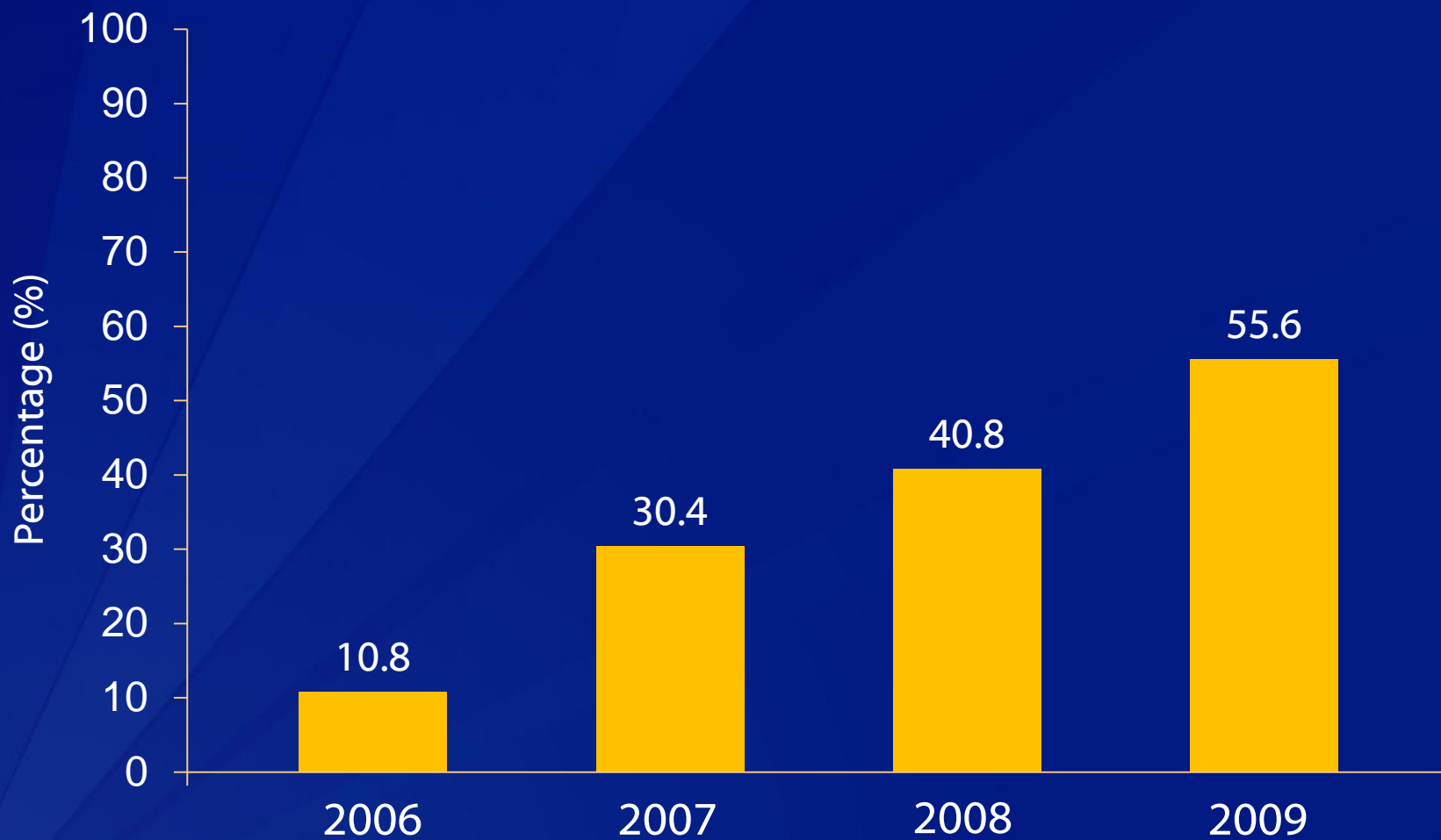
\*\*2009 Data are provisional

# **TDAP IMPLEMENTATION AND EVALUATION**

# Proportion of reported pertussis cases by age group - 1990-2009



# Tdap coverage among adolescents aged 13-17 years – 2006-2009



CDC. National, State, and Local Area Vaccination Coverage Among Adolescents Aged 13-17 Years - United States, 2008. MMWR 2009;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.

# Tdap Vaccine Effectiveness

- Bridging studies of ADACEL and BOOSTRIX<sup>1</sup>
  - 85-89%
- APERT study<sup>2</sup>
  - 92% (95% CI: 32.0-99.0)
- Australia<sup>3</sup> – screening method
  - 78.0% (95% CI: 60.7-87.6)
- St. Croix outbreak<sup>4</sup> – case-control study
  - 65.6% (95% CI: 35.8-91.3)
- MN case-control study (poster #80)
  - 72.3% (95% CI: 38.8-87.4)

<sup>1</sup> Schmitt HJ et al. JAMA 1996;275:37-41; Gustafsson LH et al. NEJM 1996;334:349-355

<sup>2</sup> Ward JI et al. N Engl J Med. 2005 Oct 13;353(15):1555-63.

<sup>3</sup> Rank C, et al. Pediatr Infect Dis J. 2009 Feb;28(2):152-3.

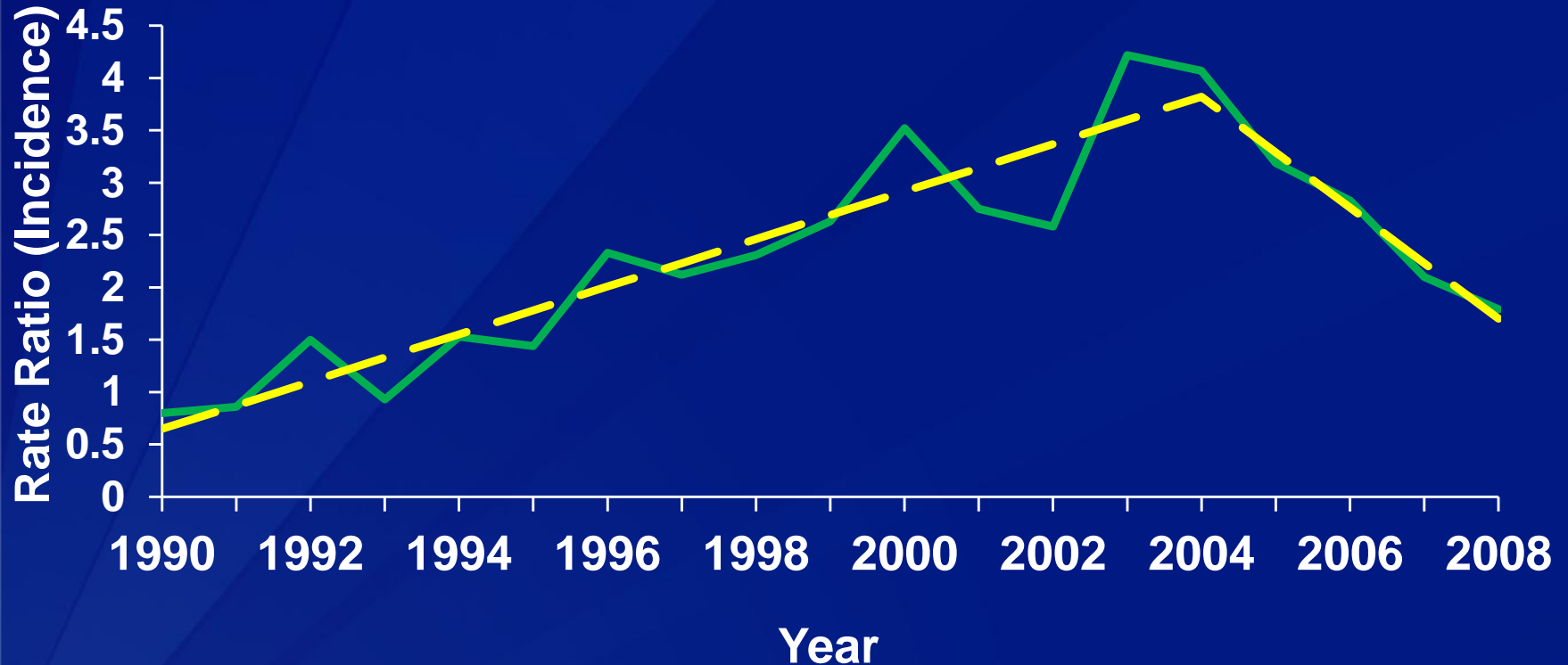
<sup>4</sup> Wei SC, et al. CID 2010; 51(3):315-321.

# Incidence of reported pertussis - 1990-2008



# Accelerated decline of pertussis

Rate ratios of pertussis incidence among adolescents 11-18 years, 1990-2008



— 11-18 years of age vs. all other age groups combined