Pertussis: Is It worth Vaccinating?

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WHOOPING COUGH—ITS NATURE AND PREVENTION.

A POPULAR DISCUSSION OF A WIDESPREAD AND DANGEROUS DISEASE FOR WHICH FAMILIARITY HAS BRED CONTEMPT.

By W. C. RUCKER, Assistant Surgeon General, United States Public Health Service.

"It is estimated that whooping cough killed over 10,000 American children in the year of 1911"

"It is a serious disease affecting the public health and demanding earnest attention"

Public Health Importance of Pertussis

- Highly contagious respiratory disease

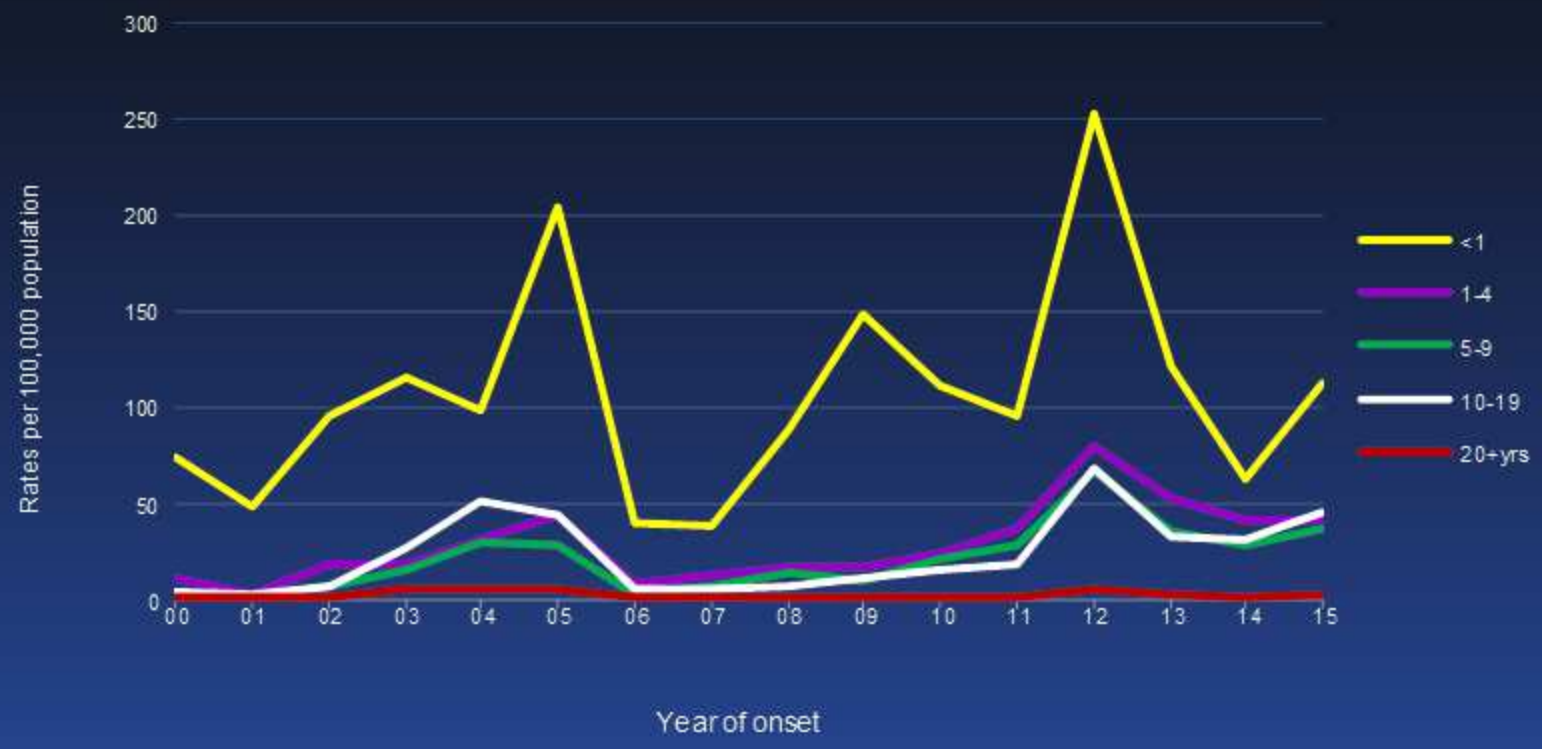
  - *Bordetella pertussis*

- Severe, debilitating cough illness (“100 day cough”) in persons of all ages

- Highest morbidity and mortality among infants

- Poorly controlled, despite high vaccine coverage

Pertussis Incidence by Age Group, Oregon, 2000–2015



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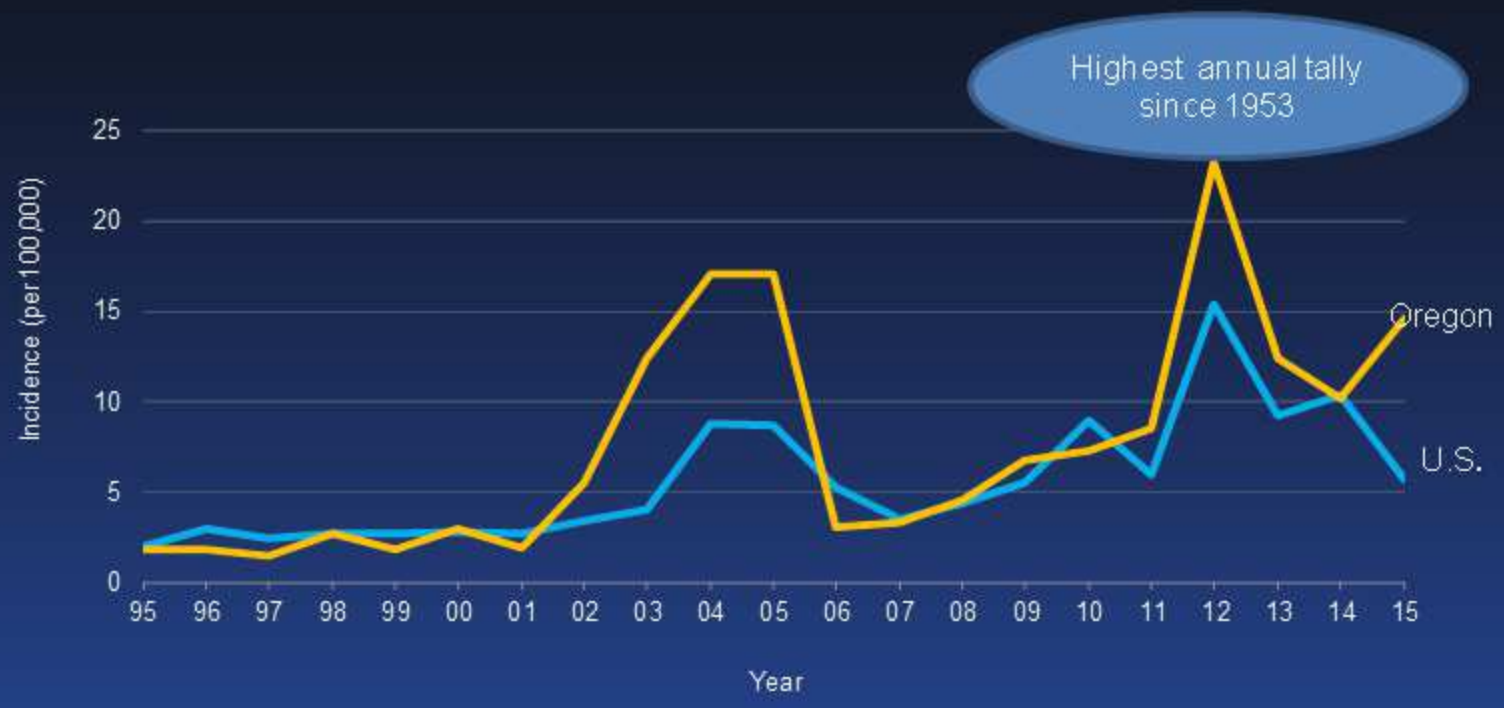
Reported Pertussis Incidence Rates in the United States and Oregon, 1995–2015



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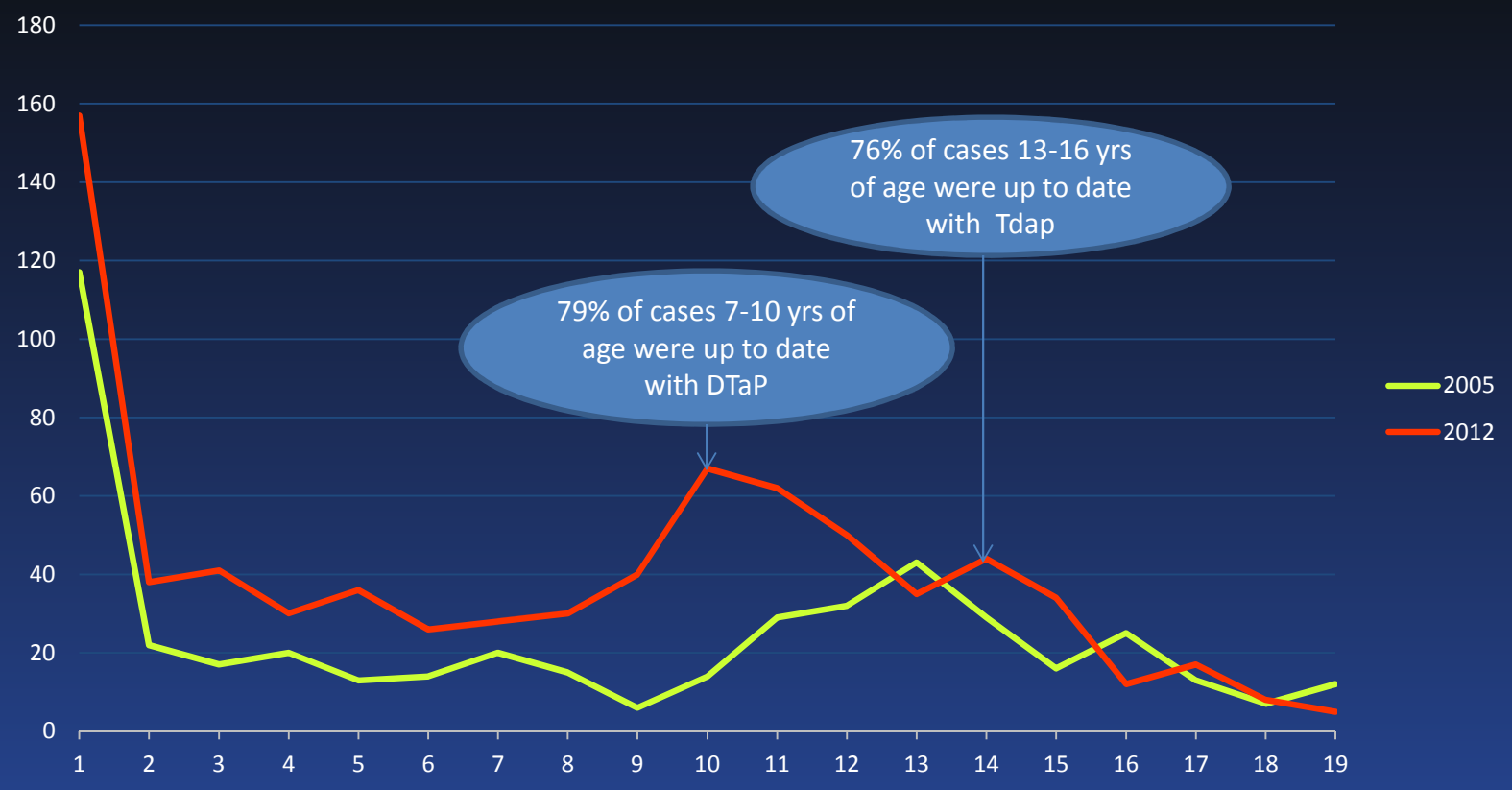
OR Pertussis Cases by Age: 2005 and 2012



Estimate the effectiveness of currently recommended pertussis vaccines — DTaP in infancy and early childhood and Tdap in adolescence

Methods

- Cases from Orpheus
- Population estimates from ALERT IIS
- Cohort-specific incidence rates by age and vaccination status
- Risk ratios of the incidence of disease among those unvaccinated or partially vaccinated to those up to date
- Vaccine effectiveness

Pertussis among children and adolescents 2 months – 19 years, by vaccination status, Oregon, 2012

Age	Cumulative Incidence per 100.000 by vaccination status			RR Unvax/UTD	RR Partial/UTD	VE(%)
	UTD	Partial	Unvax			
2–3 mo	225.1		833.3	3.7		73
4–5 mo	139.9	285.7	493.8	3.5	2.0	72
6–14 mo	80.7	145.6	572.7	7.1	1.8	86
15 mo–47 mo	39.9	119.3	823	20.6	3.0	95
4–6 yr	47.8	64.3	430.6	9.0	1.3	89
7–10 yr	69.3	144.4	414.6	6.0	2.1	83

Pertussis among children and adolescents 2 months – 19 years, by vaccination status, Oregon, 2012

Age	Cumulative incidence per 100.000 by vaccination status		RR	VE(%)
	UTD	Unvaccinated		
11–12 yr	57.9	166.1	2.9	65
13–16 yr	56.4	105.3	1.9	47
17–19 yr	12.6	37.1	2.9	66

Clin Infect Dis.2014 Jul 15;59(2):261-3.

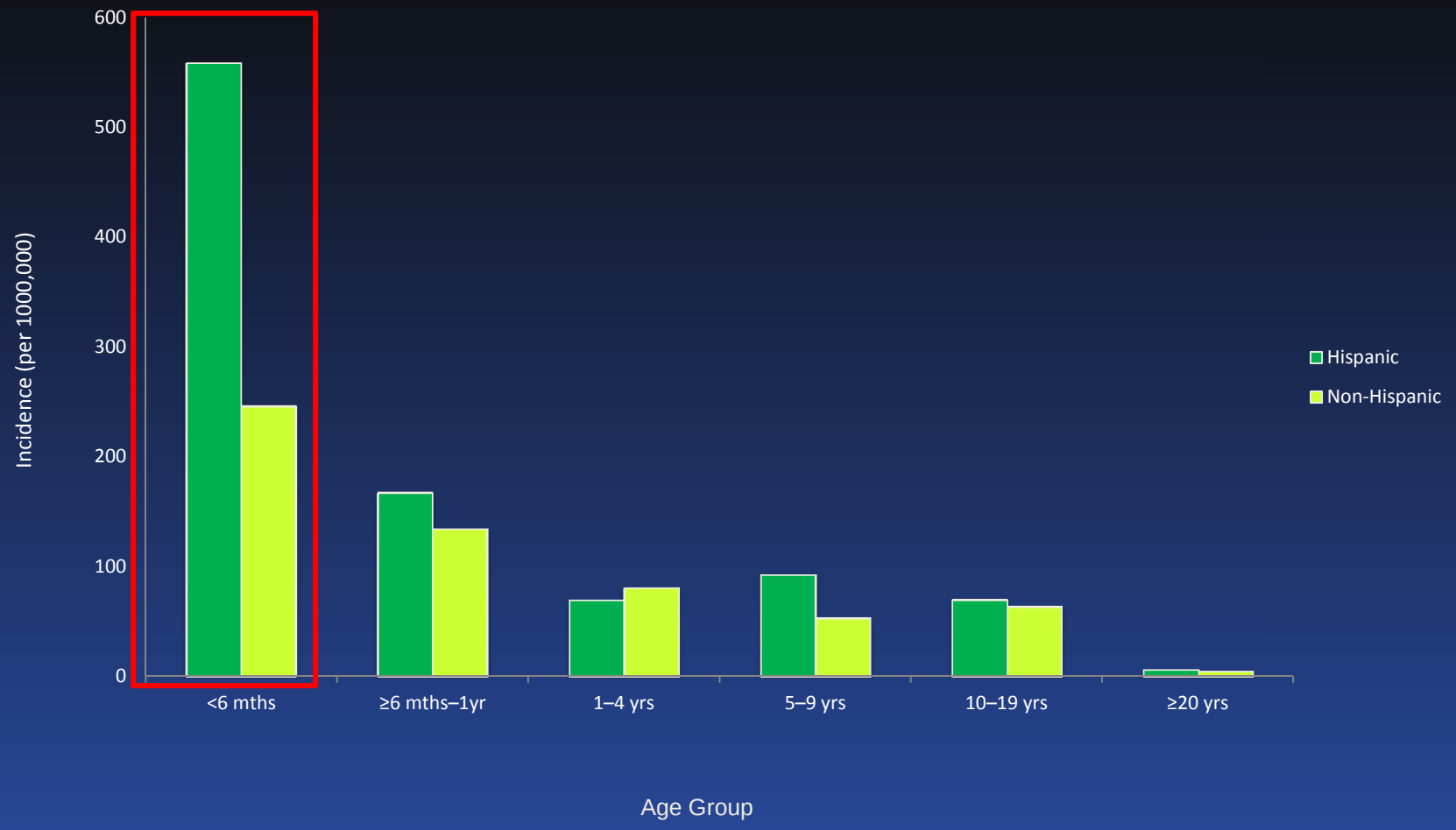
Pertussis: Pertinacious But Still Vaccine-Vulnerable

- Vaccine still works – our data show that clearly
  - One is better off with vaccination than without it
  - Declining the vaccine carries a whopping risk for whooping cough

- Even when we see epidemic disease, we find that the vaccine is protective

Clin Infect Dis.2014 Jul 15;59(2):261-3.

Reported Pertussis Incidence, by Age and Ethnicity Oregon, 2012



Risk Factors for Pertussis in Hispanic Infants - Metropolitan Portland, Oregon, 2010–2012

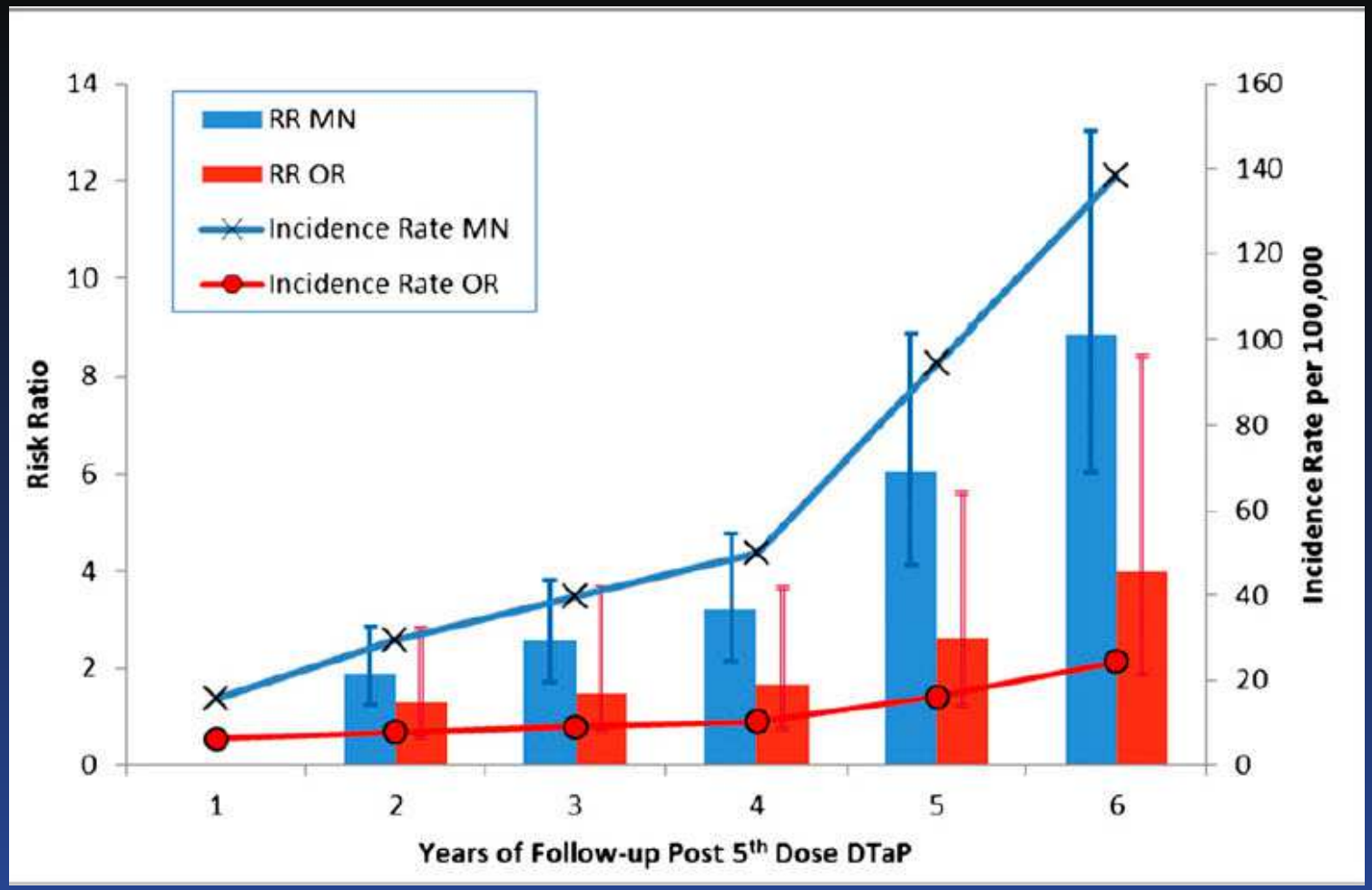
- Pertussis rates among Hispanic infants were greater than non-Hispanic infants aged <6 months
- Similar vaccination rates among Hispanic and non-Hispanic infants aged <6 months
- Household size of >4 persons is a potential risk factor for pertussis
- Greater proportion Hispanic infants in households >4

Pediatr Infect Dis J. 2016 May;35(5):488-93.

Assessment of risk following childhood pertussis vaccination

- Registry data for vaccination (children born 1998–2003)
- Pertussis surveillance data for cases
- Children with 5th DTaP dose received aged 4–6 years
- Minnesota: 224,378 subjects and 458 cases
- **Oregon**: 179,011 subjects and 89 cases

Pertussis, by time since 5th DTaP Minnesota and Oregon, 2010



Pediatrics. 2013 Apr;131(4):1047-52.

"Down in the Valley
And not far off
A blue jay died of a whooping cough
He whooped and he whopped
And he whooped some more
He whooped his head and tail right off"
-- *Whooping Cough Camp Song*

Pertussis: Suffer the Infants

A Complicated Case of Pertussis

- Hospitalized for 3 months
  - Intensive Care Unit for 75 days
  - Mechanical ventilation for 72 days
  - ECMO for 43 days
- Complications
  - Kidney failure
  - Stroke
- Lab reports — *Bordetella pertussis*
- Exposure history
  - Siblings vaccinated
  - Mother declined vaccine and noted coughing
- Hospitalization costs = $1,500,000
- At 23 mo of age, persistent language and right-sided motor deficits in the distribution of stroke

Public Health Rep. 2015 Sep-Oct;130(5):435-9

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Pertussis incidence among infants, Oregon, 2003–2014

Percent of infant cases hospitalized, Oregon, 2003-2014 *

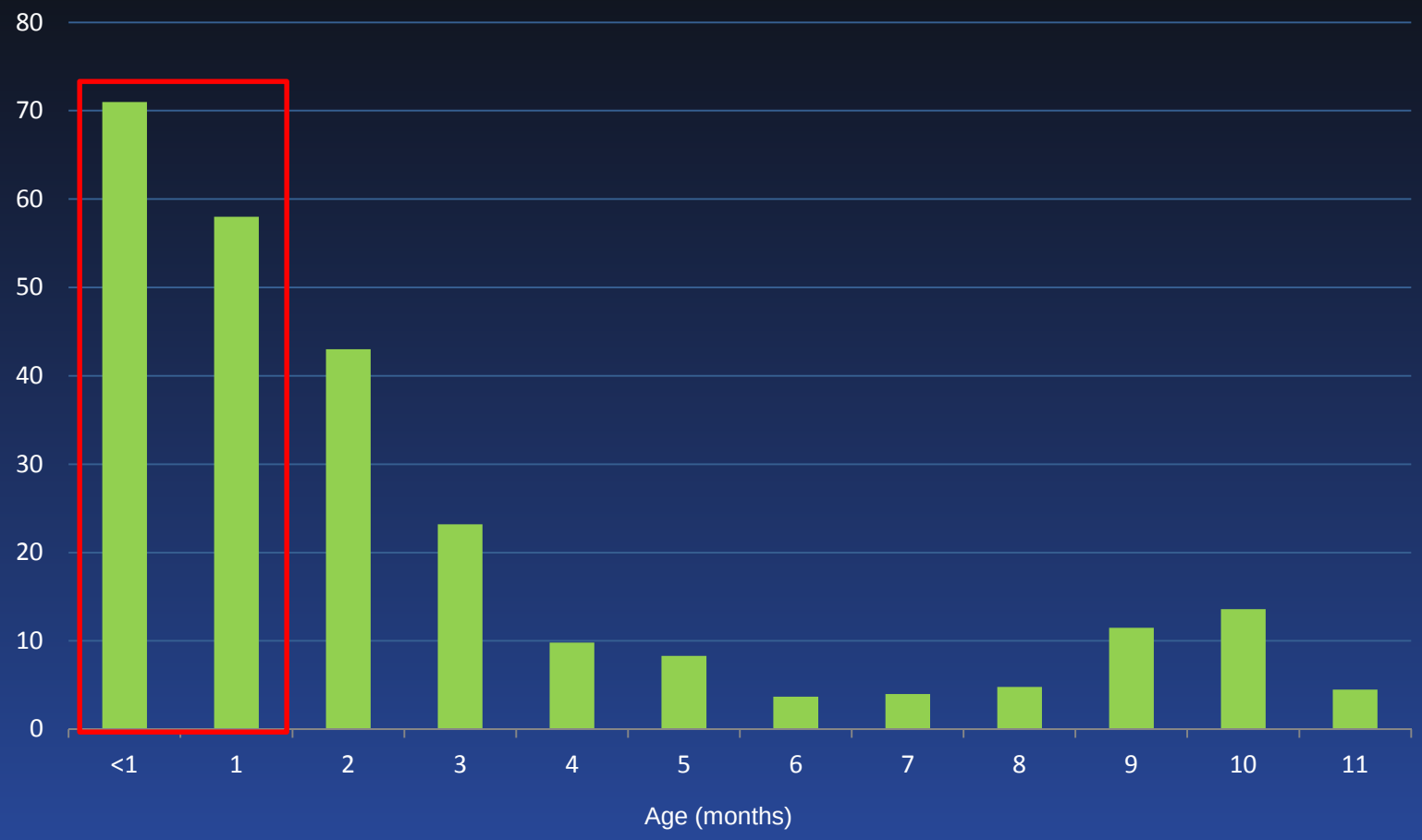

Chart review on hospitalized infants with pertussis, Oregon, 2/2009 – 2/2013

Photo courtesy of CDC

- 285 infant cases reported with pertussis
- One infant <6 months old died
- 1462 non-infant cases and only 19 (1%) hospitalized
- 94 (33%) infant cases hospitalized
- Length of stay (LOS); median of 4 (range, 1 – 128) days; 805 hospital days
- 59 (63%) of the infant cases were <2 months old

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Chart review on hospitalized infants with pertussis, Oregon, 2/2009 – 2/2013

- 27 (29%) infants admitted in ICU; LOS: 3 (1 - 128); 322 ICU days
- 7 (7%) infants required mechanical ventilation; duration: 12 (4 - 83); 185 days
- Two infant supported with extracorporeal membrane oxygenation (ECMO) for a total of 87 days
- One infant discharged on oxygen
- One infant discharged with a tracheostomy to be ventilated mechanically for 10 hrs. each night. The infant spent 128 days in the hospital, was mechanically ventilated for 83 days and received ECMO for 44 days.

Public Health Rep. 2015 Sep-Oct;130(5):435-9

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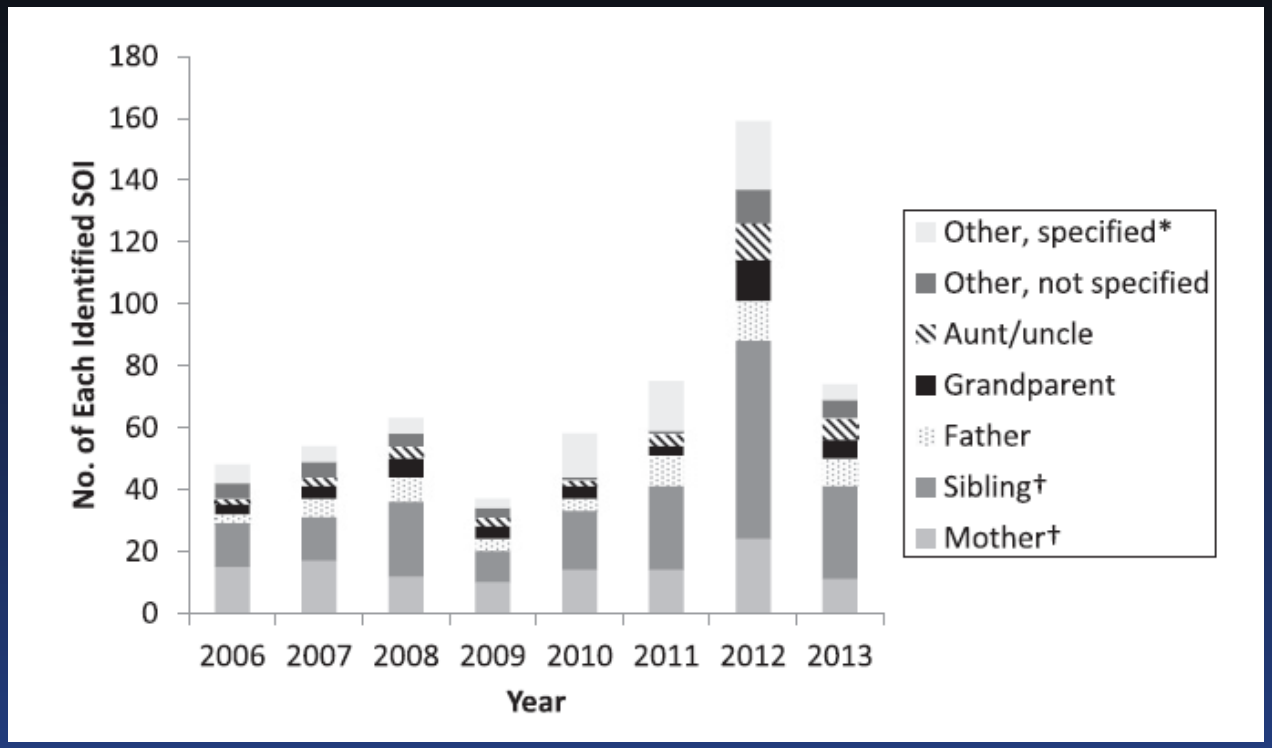
Source of infants pertussis in the United States, 2006-2013



* Includes day-care contacts, cousins, friends, babysitters, and nieces/nephews, unknown source (n = 1). † P < .05

- SOI identified for 44% of infant pertussis cases
- 66%-85% of identified sources were classified as family members
- The most common sources: siblings (35.5%), mothers (20.6%), fathers (10%), grandparents (7.6%), aunts/uncles (6.5%), other not specified (6.3%) and other specified (5%).

Pediatrics. 2015 Oct;136(4):635-41.

ACIP Tdap recommendations
Preventing infant pertussis

- **2005**
  - "Cocooning" all close contacts of infants
  - Post-partum dose
- **2011**
  - During pregnancy (if previously not received Tdap)
  - Post-partum dose – if not during pregnancy
- **2012**
  - During each pregnancy, irrespective of prior Tdap history
    - Optimal timing is between 27 and 36 weeks gestation
  - Post-partum dose – if not during pregnancy and if never previously received Tdap

High effectiveness of maternal pertussis vaccination -- United Kingdom

Observational study

- **Vaccine screening method**
- **For infants <3 mths of age at onset of pertussis**

Vaccine effectiveness		Timing of maternal vaccination
91%	(83-95)	At least 28 days before birth
38%	(-95-80)	0-6 days before or 1-13 days after birth

Case-Control study

- **Cases: infants <2 mths of age at onset pertussis infection**
- **Unadjusted VE = 91% (77%-97%)**
- **Adjusted VE = 93% (81%-97%)**

Lancet. 2014 Oct 25;384(9953):1521-8.
Clin Infect Dis. 2015 Feb 1;60(3):333-7.

Winnable Battles in Pertussis

"Whooping cough is a danger to be avoided and combated in the interest of humanity and the citizens of tomorrow" Dr. Rucker

- **Vaccination is our best prevention tool**

  - Vaccinating pregnant women every pregnancy

  - A baby's first dose of pertussis vaccine should be the one its mother gets

  - Timely vaccination of infants

  - Maximizing other current pertussis vaccination strategies

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Subacute sclerosing panencephalitis (SSPE)

Previously healthy school-aged child born in Asia and admitted with progressive and severe encephalopathy.

4 months prior, began nodding off while doing homework, started having difficulty with math (previously math whiz) and having shoulder shrugs. Continued getting worse: child would start falling asleep while walking and then would trip.

3 months prior, started having involuntary hand/arm movements, jerking every 20 min. Hand movement started increasing every 5 min, still playful and with a good sense of humor.

1 month prior, started to shuffle and walking on tip-toes, started crying continuously and began to get angry with the family, refused to walk and slept a lot and able to say only a few words. Started using diapers.

Subacute sclerosing panencephalitis (SSPE)

Admission month, progressive degeneration of mental status, making abnormal movements of arms and legs, looking around but not tracking, occasionally crying out, not responsive to questions, not following commands, withdraw to touch and pain. Unresponsive, spastic and rigid.

EEG: abnormal slowed activity with multiple spikes and sharp waves.

Lumbar puncture: Highly positive measles IgG in CSF.

The patient's clinical characteristics, typical EEG pattern, and elevated CSF measles antibody level are all consistent with SSPE, a progressive neurodegenerative disease associated with persistent measles virus infection in the central nervous system caused by aberrant viral gene expression.

Patient died in home hospice care 43 months later.

https://www.cdc.gov/mmwr/volumes/65/wr/pdfs/mm6501a3.pdf

This highlights the need to maintain very high vaccine coverage

And if we can achieve that, we will have done a far, far better thing than....well, than a lot of other things we might've done.