



# Tetanus, Diphtheria and Pertussis Vaccines

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Current Issues in Immunization

September 25, 2018

# OVERVIEW

- Diphtheria, tetanus and pertussis overview
- Vaccinating Children (DTaP)
- Vaccinating Adolescents and Adults (Tdap)
  - General recommendation/updates
  - Protecting infants from pertussis
    - Pregnant women

**Prevention of Pertussis, Tetanus, and Diphtheria  
with Vaccines in the United States:  
Recommendations of the Advisory Committee  
on Immunization Practices (ACIP)**

# Diphtheria

- Toxin-mediated disease:  
*Corynebacterium diphtheriae*
- Pharynx/Tonsils: Exudate and pseudomembrane
- Death in 5% to 10% of cases
- Vaccine coverage high
  - Diphtheria is rare in US
- Outbreaks in other countries



Pseudomembrane

# Tetanus

- A toxin-mediated disease:  
*Clostridium tetani*
- Found in soil
- Generalized tetanus:
  - Trismus (lockjaw), difficulty swallowing, muscle rigidity, spasms
- Death: 10–20% of cases



# Pertussis (whooping cough)

- Highly contagious respiratory disease
- “100 day cough”
- Highest morbidity and mortality among infants
  - Often lack classic symptoms
- Worldwide, ~16 million cases of pertussis and about 195,000 deaths per year
- Vaccine-preventable
- Poorly controlled, despite high vaccine coverage

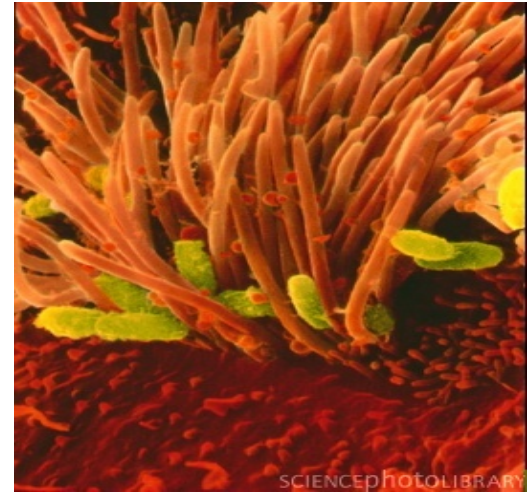
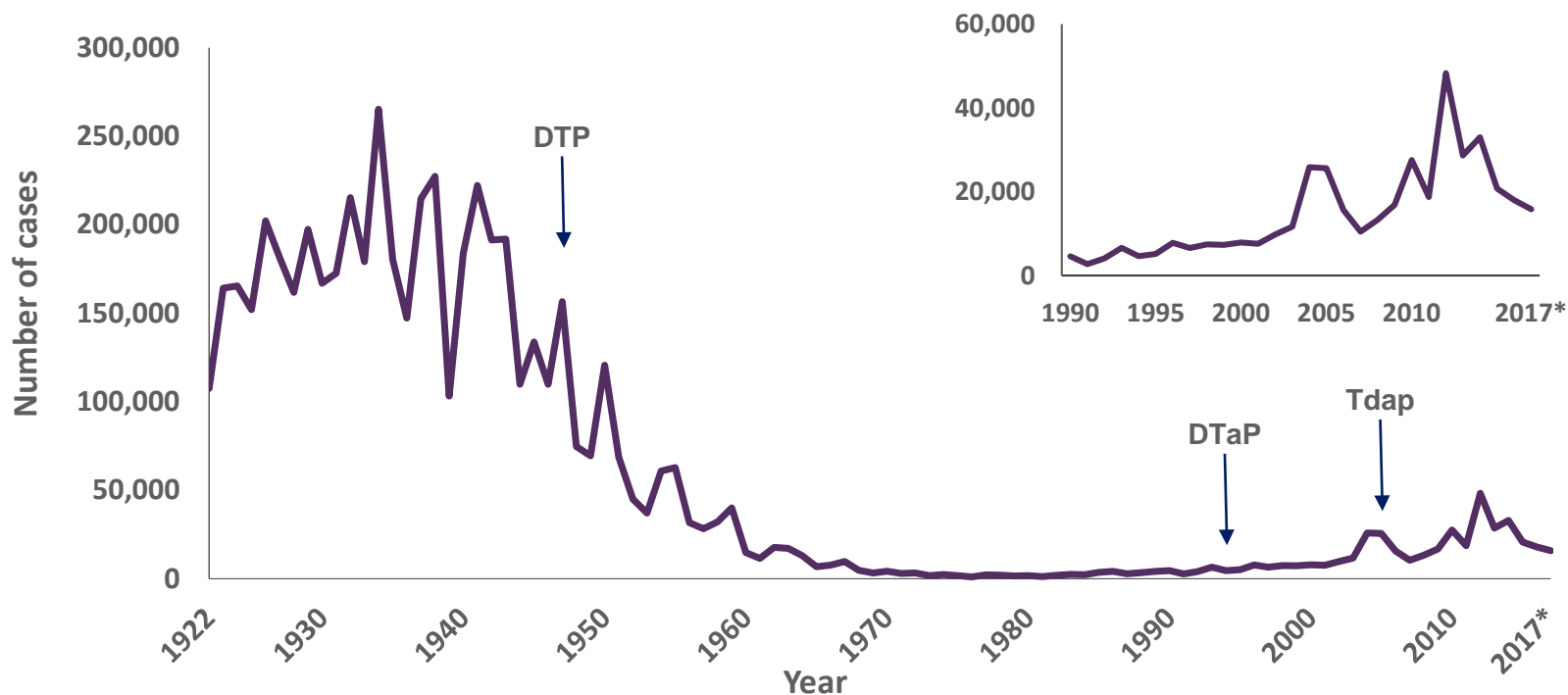


Illustration of *B. pertussis*  
attached to cilia

# U.S. REPORTED PERTUSSIS CASES: 1922-2017



\*2017 data are provisional and subject to change.

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

**DTaP**

**Tdap**

**Td**

**Birth**



# Vaccinating Children





# ACIP recommendations: 2 months to 6 years

- No recent changes
- 3 primary doses: ages 2, 4, and 6 months
- 4<sup>th</sup> dose (first booster): 15–18 months
- 5<sup>th</sup> dose (second booster): 4–6 years

Vaccine	Birth	1 mo	2 mos	4 mos	6 mos	9 mos	12 mos	15 mos	18 mos	19–23 mos	2–3 yrs	4–6 yrs	7–10 yrs	11–12 yrs	13–15 yrs	16–18 yrs
Diphtheria, tetanus, & acellular pertussis <sup>3</sup> (DTaP; <7 yrs)			1 <sup>st</sup> dose	2 <sup>nd</sup> dose	3 <sup>rd</sup> dose			← 4 <sup>th</sup> dose →				5 <sup>th</sup> dose				

# Composition of DTaP Vaccines

VaccineType	Trade name	Manufacturer	Pertussis antigens (µg)				Diphtheria toxoids (Lf)	Tetanus toxoids (Lf)	Age for licensed use				
			PT	FHA	PRN	FIM			2 mth	4 mth	6 mth	15-18 mths	4-6 yrs
<u>Single DTaP Vaccines</u>													
DTaP	INFANRIX	GSK	25	25	8		25	10	X <sup>1</sup>	X	X	X	X
DTaP	DAPTACEL <sup>2</sup>	Sanofi	10	5	3	5	15	5	X <sup>1</sup>	X	X	X	X
<u>Combination DTaP vaccines</u>													
DTaP-IPV-Hib	PENTACEL	Sanofi	20	20	3	5	15	5	X <sup>1</sup>	X	X	X	
DTaP-IPV-HepB	PEDIARIX <sup>3</sup>	GSK	25	25	8		25	10	X <sup>1</sup>	X	X		
DTaP-IPV	Kinrix	GSK	25	25	8		25	10					X
DTaP-IPV	Quadracel	Sanofi	20	20	3	5	15	5					X

Abbreviations: Pertussis toxin (PT); filamentous haemagglutinin (FHA); pertactin (PRN); fimbriae (FIM)

<sup>1</sup> Licensed for use in infants as young as 6 weeks

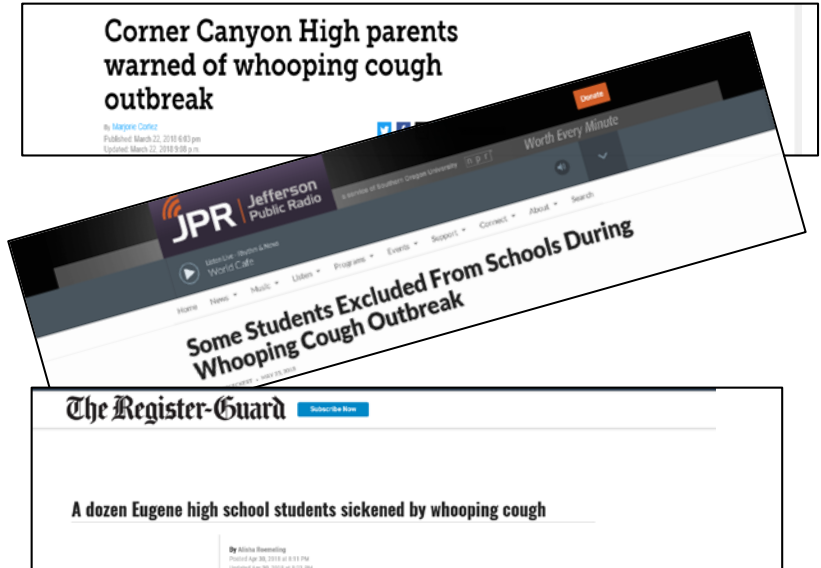
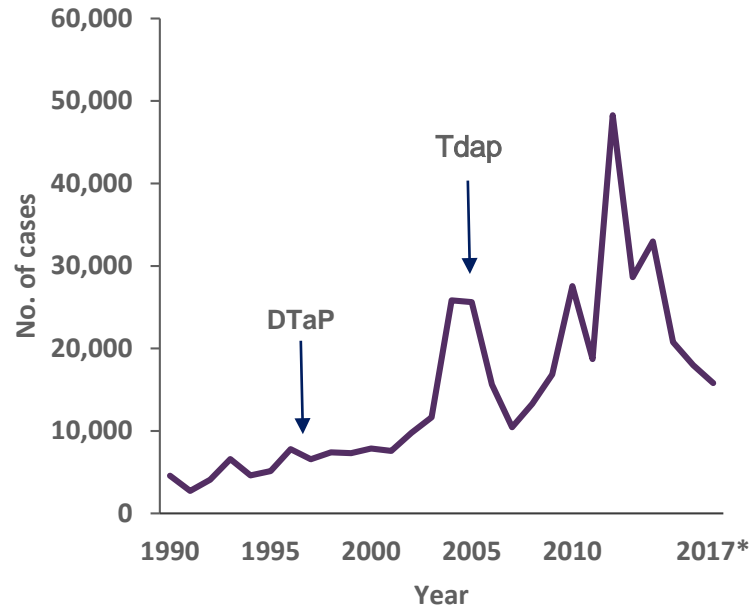
<sup>2</sup> DAPTACEL can be used for the fifth dose for a child who has received 1 or more doses of DTP

<sup>3</sup> First three doses at 6- to 8-week intervals beginning at 2 months of age; then 2 doses of DTaP are needed to complete the 5-dose series before 7 years of age



# Vaccinating Adolescents and Adults

# Waning DTaP immunity?



CDC. Preventing Tetanus, Diphtheria, and Pertussis Among Adolescents: Use of Tetanus Toxoid, Reduced Diphtheria Toxoid and Acellular Pertussis Vaccine: Recommendations of ACIP. MMWR. 2006;55(RR-3):1-43.

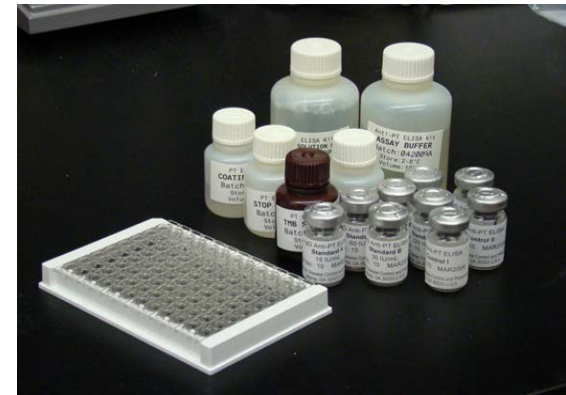
# Tdap and Td vaccines

- Tdap

- Two formulations
- First pertussis vaccines for adolescents and adults
- Combined with tetanus and diphtheria toxoids
- Licensed for single use only

- **Td**

- Tenivac (Sanofi Pasteur)
- Generic (MassBiologics)



# Current ACIP recommendations

- **Single Tdap dose**
  - **Adolescents 11–18 years**, preferred 11–12 years (2005)
  - **Adults  $\geq 19$  years** (2005)
  - No minimal time interval since last Td vaccine
- **Pregnant women** : Tdap every pregnancy (2012)
- **Decennial Td booster** for those who have received 1 Tdap
  - 5 years for wound management



# Catch-up schedule and recent updates

## Catch-up schedule:

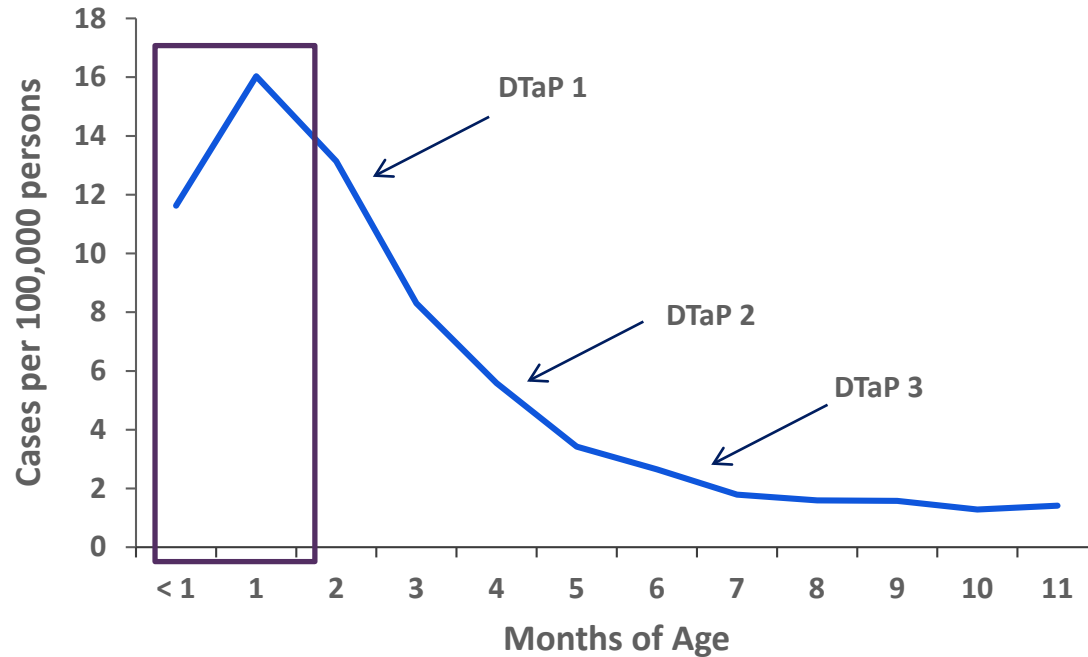
- **Persons aged 7–18 years not fully immunized with DTaP:** 1 dose of Tdap as part of the catch-up series (preferably the first dose).
  - If additional doses are needed, use Td.
  - Similar to recommendations for adults
- Change from previous guidance:
  - **Children 7–10 years** who receive Tdap inadvertently or as part of the catch-up series **SHOULD** receive routine Tdap dose at 11–12 years

**Vaccinating pregnant women**

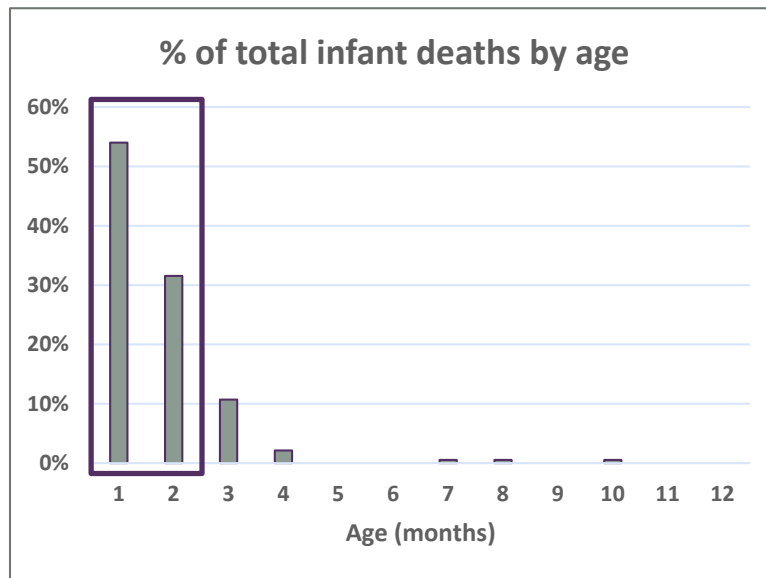
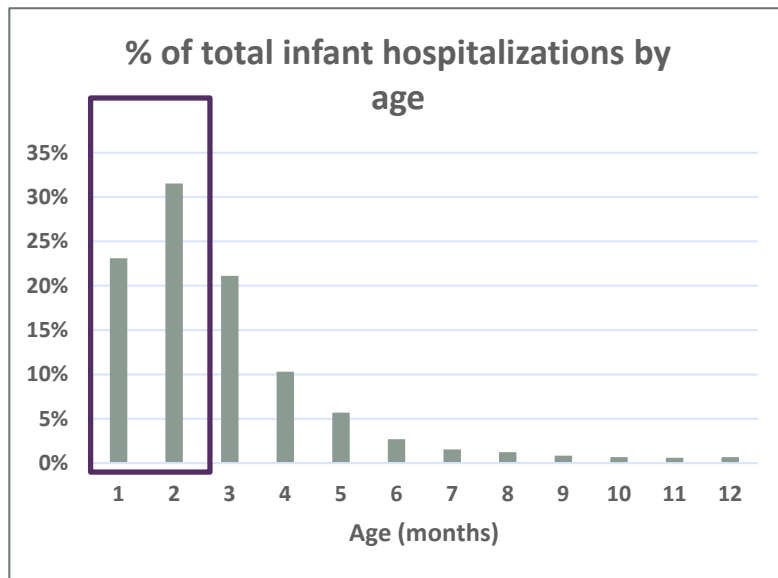




# Pertussis incidence among infants, 2001-2011



# Hospitalizations and Deaths in Infants <12 Months of Age, % Total Cases, 2004-2015, United States



\* 2015 data are provisional and subject to change

Source: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System

# “Cocooning” strategy

- Vaccinating all close contacts of infants with Tdap to reduce the risk of transmission of pertussis to these infants
  - Parents, siblings, grandparents, child-care providers and health-care personnel if they have not previously received Tdap
- Source of pertussis
  - ~50% of time, source cannot be identified
  - Parents previously primary source of transmission
  - Siblings now identified more frequently



Wendelboe AM, et al. Transmission of *Bordetella pertussis* to Young Infants. *Pediatr Infect Dis J* 2007;26: 293–299; Bisgard KM, et al. Infant pertussis: who was the source? *Pediatr Infect Dis J* 2004; 23(11):985-989; de Greeff SC, et al. Pertussis disease burden in the household: how to protect young infants. *Clin Infect Dis*. 2010 May 15;50(10):1339-45; Jardine A, et al. Who gives pertussis to infants? Source of infection for laboratory confirmed cases less than 12 months of age during an epidemic, Sydney, 2009. *Commun Dis Intell*, 2010. 34(2):116-21; Wiley KE, et al. Sources of pertussis infection in young infants: a review of key evidence informing targeting of the cocoon strategy. *Vaccine*. 2013 Jan 11;31(4):618-25; Bertilone C, et al. Finding the 'who' in whooping cough: vaccinated siblings are important pertussis sources in infants 6 months of age and under. *Commun Dis Intell Q Rep*. 2014 Sep 30;38(3):E195-200. Skoff TH et al. Pertussis in Infants: Source of Infection Following Tdap Introduction. Oral Presentation. 2012 Council of State and Territorial Epidemiologists Conference (CSTE) Conference, Omaha, NE, June 3-7, 2012.

# ACIP Tdap recommendation for pregnant women

- A dose of Tdap during EACH pregnancy
  - Previous Tdap history not considered
- Maximize maternal antibody response and passive antibody transfer to the infant
- Optimal timing for Tdap administration: 27 and 36 weeks gestation



# Studies show that maternal Tdap vaccination very effective at preventing infant pertussis infection

			Definitions
	Vaccine effectiveness (95% confidence intervals)	Infant age at pertussis onset	Mother gestational age received Tdap
<u>United Kingdom</u>			
Observational <sup>1</sup> , screening method	91% (83%-95%)	<3 mths	at least 28 days before birth*
Case-Control <sup>2</sup> , retrospective	91% (77%-97%), unadjusted 93% (81%-97%), adjusted <sup>¶</sup>	<2 mths	cases: 31.5 wks (range, 28–38) controls: 33 wks (range, 26–38)
<u>United States</u>			
Cohort <sup>3</sup> , retrospective	85% (33%-98%)	<2 mths	27-36 wks vs. postpartum Tdap
Case-Control <sup>4</sup> , retrospective	78% (44%-91%)	<2 mths	27-36 wks

\*2012 UK recommendation: Tdap between 28 and 38 weeks

¶ Adjusted for sex, geographical area, and birth period

<sup>1</sup>Amirthalingam G, et al. 2014; <sup>2</sup>Dabrera G, et al. 2015; <sup>3</sup>Winter K, et al. 2016; <sup>4</sup>Skoff, 2017

# Maternal Tdap Decreases Disease Severity in Infants

Infants born to vaccinated mothers:

- Older when developed pertussis
- Less likely have classic symptoms
- Lower risk of hospitalization and ICU admission
- No deaths due to pertussis



# Vaccination coverage



“The whooping cough vaccine I got during my 3<sup>rd</sup> trimester will help protect my baby starting at her first breath.”

Whooping cough can make your baby very sick with coughing fits and gasping for air. It can even be deadly, and there are outbreaks happening across the United States. When you get the whooping cough vaccine (also called Tdap) during the third trimester of your pregnancy, you'll pass antibodies to your baby that will help protect her from this disease from the time she's born. These antibodies will last for the first few months of her life, when she is most vulnerable to serious disease and complications.

Talk to your doctor or midwife about the whooping cough vaccine.

 U.S. Department of Health and Human Services  
Centers for Disease Control and Prevention

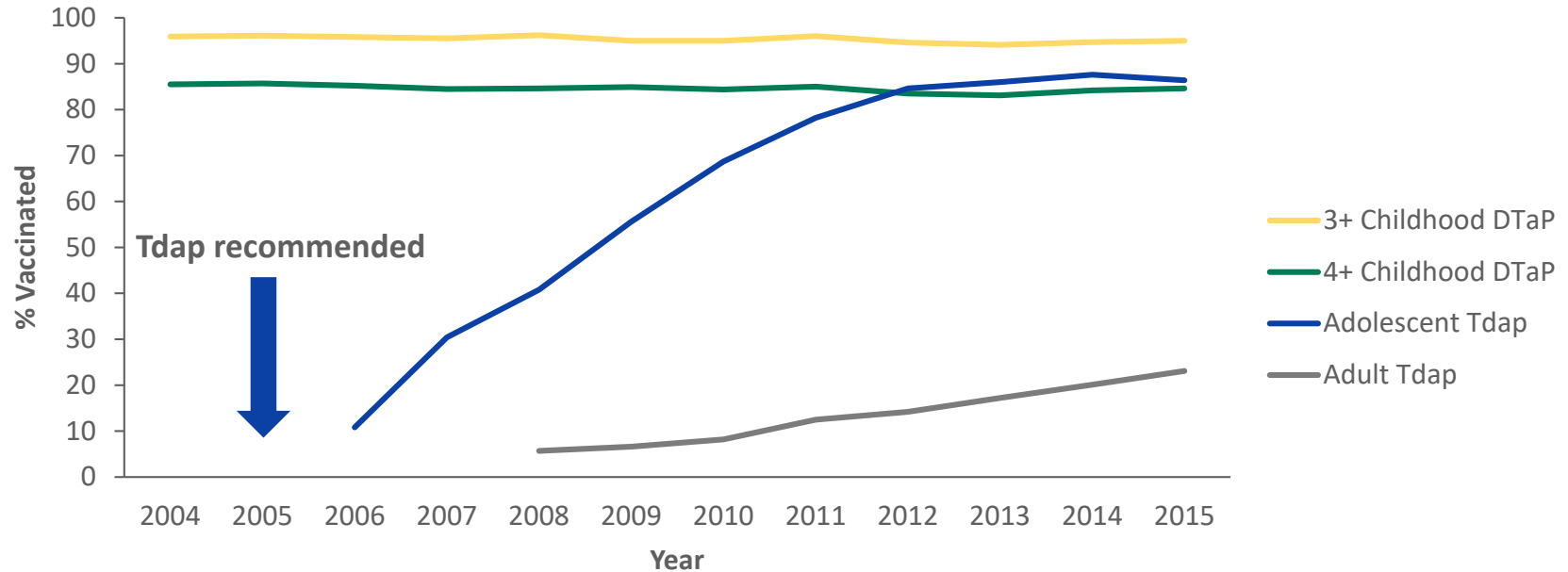
Born with protection against whooping cough.  
[www.cdc.gov/whoopingcough](http://www.cdc.gov/whoopingcough)

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Advancing women's health

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# Pertussis Vaccination Coverage\* Among The U.S. Population, 2004-2015



\*CDC National Immunization Survey: DTaP among children aged 19 through 35 months, Tdap coverage among adolescents aged 13 through 17 years; <sup>1</sup>Coverage among adults aged 19 through 64 years from National Health Information Survey



# Barriers to vaccinating pregnant women

- Tdap coverage in pregnant women suboptimal
- Undocumented Tdap vaccine history
- Some programs still focused on postpartum Tdap
- Getting the message out
  - Initiatives to improve vaccination of pregnant women
- Provider recommendation best predictor of vaccination
- Optimal if provider recommends vaccine AND offers it

Getting your whooping cough vaccine in your 3<sup>rd</sup> trimester...

helps protect your baby from the start.

Outbreaks of whooping cough are happening across the United States. This disease can cause your baby to have coughing fits, gasp for air, and turn blue from lack of oxygen. It can even be deadly. When you get the whooping cough vaccine (also called Tdap) during your third trimester, you'll pass antibodies to your baby. This will help keep him protected during his first few months of life, when he is most vulnerable to serious disease and complications.

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The Society of Women Physicians

Tong A, et al. A cross-sectional study of maternity care providers' and women's knowledge, attitudes, and behaviours towards influenza vaccination during pregnancy. MJ Obstet Gynaecol Can. 2008 May;30(5):404-10.

Meharry et al. Reasons Why Women Accept or Reject the Trivalent Inactivated Influenza Vaccine (TIV) During Pregnancy Matern Child Health J. 2012 Feb 25.

# Conclusions

- DTaP coverage high in children
- Tdap coverage
  - Adolescent coverage high
  - Adult coverage and coverage in pregnant women could be improved
  - Remove barriers to vaccination of pregnant women and increase Tdap coverage during pregnancy

# Acknowledgements

## Division of Bacterial Diseases

- Susan Hariri
- Anna Acosta
- Amanda Faulkner
- Tami Skoff
- Jennifer Liang

## Immunization Services Division

- Andrew Kroger
- Melissa Barnett
- Dale Babcock

# Thank you

For more information, contact CDC  
1-800-CDC-INFO (232-4636)  
TTY: 1-888-232-6348 [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.

