Pneumococcal Disease and Pneumococcal Vaccines

September 2019

Chapter 17
Disease
Streptococcus pneumoniae

- Gram-positive bacteria
- 92 known serotypes
- Polysaccharide capsule important virulence factor
- Type-specific antibody is protective
- Limited cross-reactivity
Pneumococcal Disease

- Second most common cause of vaccine-preventable disease in the U.S.

- Major clinical syndromes
  - Pneumonia
  - Bacteremia
  - Meningitis

https://www.cdc.gov/pneumococcal/clinicians/clinical-features.html
Invasive Pneumococcal Disease Incidence by Age Group–2017*

*CDC Active Bacterial Core surveillance 2017 report: http://www.cdc.gov/abcs/reports-findings/survreports/spneu17.html
invasive pneumococcal disease (IPD) among children <5 years old, 1998--2016, United States

https://www.cdc.gov/pneumococcal/surveillance.html
Trends in Invasive Pneumococcal Disease among Adults 19–64 Years of Age, 1998–2016

https://www.cdc.gov/pneumococcal/surveillance.html
Trends in Invasive Pneumococcal Disease among Adults 65 Years of Age and Older, 1998–2016


PCV7 introduction

PCV13 recommendations for immunocompromised adults 19+

PCV13 introduction for children

PCV13 recommendations for adults 65+

*PPSV23 serotypes: 1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19A, 19F, 20, 22F, 23F, and 33F

*PCV13 serotype: 1, 3, 4, 5, 6A, 6B, 7F, 9V, 14, 18C, 19A, 19F, and 23F

https://www.cdc.gov/pneumococcal/surveillance.html
Risk Factors for Invasive Pneumococcal Disease

- Functional or anatomic asplenia, including sickle-cell disease
- Altered immunocompetence
- Underlying medical conditions, including chronic renal disease, nephrotic syndrome, and CSF leak
- Cochlear implant
Pneumococcal Disease Epidemiology

- **Reservoir**
  - Human carriers

- **Transmission**
  - Respiratory and autoinoculation

- **Temporal pattern**
  - Winter and early spring

- **Communicability**
  - Unknown; probably as long as organism in respiratory secretions
Incidence of IPD in Adults Age 18–64 Years with Selected Underlying Conditions, United States, 2009

Cases Per 100,000 Persons

- **HEALTHY**: 8
- **CVD**: 26
- **DIABETES**: 28
- **PULMONARY**: 32
- **KIDNEY**: 41
- **LIVER**: 52
- **ALCOHOL**: 59
- **HIV/AIDS**: 173
- **HEMATOLOGICAL CANCER**: 186

3-7 fold increased risk

20 fold increased risk

Unpublished data, Active Bacterial Core surveillance, 2009
Pneumococcal Vaccines

- **1977**: 14-valent polysaccharide vaccine licensed
- **1983**: 23-valent polysaccharide vaccine licensed (PPSV23)
- **2000**: 7-valent polysaccharide conjugate vaccine licensed (PCV7)
- **2010**: 13-valent polysaccharide conjugate vaccine licensed (PCV13)
# Pneumococcal Vaccine Products

<table>
<thead>
<tr>
<th>Vaccine product</th>
<th>Age indications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pneumococcal Polysaccharide Vaccine</strong></td>
<td></td>
</tr>
<tr>
<td>Pneumovax 23 (PPSV23)</td>
<td>50 years of age or older and persons age ≥2 years who are at increased risk for pneumococcal disease</td>
</tr>
<tr>
<td><strong>Pneumococcal Conjugate Vaccine</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Prevnar 13 (PCV13)                               | Children: 6 weeks–18 years  
Adults: 19 years and older                                                       |
PCV7 Introduction among U.S. Children and Its Impact on Invasive Pneumococcal Disease

- PCV7 introduced into routine schedule 2000

Rates of IPD among Children <5 yrs old

- Overall -76 (-79,-73)
- PCV7 type -100 (-100,-99)

Moore, IDSA, 2009, and CDC, unpublished data
Pneumococcal Conjugate Vaccine (PCV13) in Children

- In 2008, 61% of invasive pneumococcal disease cases among children younger than 5 years were attributable to the serotypes included in PCV13
Pneumococcal Conjugate Vaccine (PCV13) in Adults

- In 2013, 20%–25% of invasive pneumococcal disease cases among adults 65 years old and older were attributable to PCV13 serotypes.

- 10% of community-acquired pneumonia in adults due to PCV13 serotypes.
Pneumococcal Polysaccharide Vaccine (PPSV23)
Immunogenicity/Effectiveness

- Most estimates range between 60%–70% effective against invasive disease among immunocompetent older persons and adults with underlying illnesses

- Effectiveness among immunocompromised or very old persons not demonstrated
Pneumococcal Conjugate Vaccine (PCV13) Immunogenicity/Efficacy

- Highly immunogenic in infants and young children, including those with high-risk medical conditions

- PCV7 was 97% effective against invasive disease caused by vaccine serotypes (presumably PCV13 as well)
## New Evidence Supporting PCV13 Use among Adults, CAPiTA Results

<table>
<thead>
<tr>
<th>Study/Population</th>
<th>Endpoint</th>
<th>Vaccine Efficacy (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPiTA</td>
<td>PCV13-serotype IPD</td>
<td>75% (41%, 91%)</td>
</tr>
<tr>
<td>~85,000 Adults 65+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>PCV13-serotype nonbacteremic pneumonia</td>
<td>45% (14%, 65%)</td>
</tr>
</tbody>
</table>
Clinical Considerations
Prevention of Pneumococcal Disease Among Infants and Children — Use of 13-Valent Pneumococcal Conjugate Vaccine and 23-Valent Pneumococcal Polysaccharide Vaccine

Recommendations of the Advisory Committee on Immunization Practices (ACIP)
ACIP PCV13 Vaccine Recommendations: Pediatric

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Birth</th>
<th>1 mo</th>
<th>2 mos</th>
<th>4 mos</th>
<th>6 mos</th>
<th>9 mos</th>
<th>12 mos</th>
<th>15 mos</th>
<th>18 mos</th>
<th>19-23 mos</th>
<th>2-3 yrs</th>
<th>4-6 yrs</th>
<th>7-10 yrs</th>
<th>11-12 yrs</th>
<th>13-15 yrs</th>
<th>16 yrs</th>
<th>17-18 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumococcal conjugate (PCV13)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Routinely recommended for infants and children 2 through 59 months of age
  - 4 doses at 2, 4, 6, and 12 to 15 months
  - Fewer doses if series started at 7 months of age or older

- Children who have received 1 or more doses of PCV7 should complete the immunization series with PCV13
## Pneumococcal Conjugate Vaccination Schedule for Unvaccinated Older Children: Primary Series

<table>
<thead>
<tr>
<th>Age at First Dose</th>
<th># of Doses</th>
<th>Booster</th>
</tr>
</thead>
<tbody>
<tr>
<td>7–11 months</td>
<td>2 doses</td>
<td>Yes</td>
</tr>
<tr>
<td>12–23 months</td>
<td>2 doses*</td>
<td>No</td>
</tr>
<tr>
<td>24–59 months</td>
<td>1 dose</td>
<td>No</td>
</tr>
<tr>
<td>24–71 months, with medical conditions**</td>
<td>2 doses*</td>
<td>No</td>
</tr>
</tbody>
</table>

*Separated by at least 8 weeks; see *MMWR* 2010;59(RR-11):1–19, at [https://www.cdc.gov/mmwr/pdf/rr/rr5911.pdf](https://www.cdc.gov/mmwr/pdf/rr/rr5911.pdf)

**Chronic heart, lung disease, diabetes, CSF leak, cochlear implant, sickle cell disease, other hemoglobinopathies, functional or anatomic asplenia, HIV infection, immunocompromising conditions
ACIP recommended use of PCV13 for immunocompromised persons 6 years and older (2012, 2013)

ACIP recommended use of PCV13 for all adults 65 years or older in 2014
ACIP Recommendations for PCV13 Dose

- A dose of PCV13 should be administered to children 6 through 18 years of age who are at increased risk for invasive pneumococcal disease* (and no prior PCV13 doses)
  - Functional or anatomic asplenia, including sickle cell disease
  - HIV infection and other immunocompromising conditions
  - Cochlear implant
  - CSF leak

- Regardless of previous history of PCV7 or PPSV vaccine

*Off-label recommendation, MMWR, June 28, 2013, Vol 62, #25
Pneumococcal Conjugate (PCV13) Vaccine Administration

- Administer PCV13 vaccine via intramuscular (IM) injection
  - Needle gauge: 22–5 gauge
  - Needle length*: 5/8–1.5 inch, depending on the patient’s age and/or weight
  - Site*:
    - Birth–11 months: Vastus lateralis muscle is preferred
    - 1–2 years: Vastus lateralis muscle is preferred; deltoid muscle may be used if the muscle mass is adequate
    - 3 years and older: Deltoid muscle is preferred; vastus lateralis muscle may be used

- Administer at the same medical visit as other vaccines except MenACWY-D in asplenic persons (others, ok to administer)

*Professional judgement should be used to determine the proper needle length and site. Factors influencing site include local reaction, number of vaccines to be administered, age, and muscle mass
ACIP PCV13 Vaccine Recommendations: Adults

Recommended for adults 19–64 years at increased risk

Routinely recommended for adults age 65 years or older, 2014 to 2019

Now recommend shared clinical decision making before vaccination

MMWR, October 12, 2012, Vol 61, #40, and MMWR. 2014;63(37);822-5.
Recommended for children 2–18 years at increased risk

When both PCV13 and PPSV23 are indicated, administer PCV13 first

PCV13 and PPSV23 should not be administered at the same visit
ACIP PPSV23 Vaccine Recommendations: Adults

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>19–21 years</th>
<th>22–26 years</th>
<th>27–49 years</th>
<th>50–64 years</th>
<th>≥65 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumococcal polysaccharide (PPSV23)</td>
<td>1 or 2 doses depending on indication</td>
<td></td>
<td></td>
<td></td>
<td>1 dose</td>
</tr>
</tbody>
</table>

- Routinely recommended for adults 65 years or older at least 1 year after receiving PCV13
- Recommended for adults 19–64 at increased risk
- When both PCV13 and PPSV23 are indicated, administer PCV13 first
- PCV13 and PPSV23 should not be administered at the same visit
Pneumococcal Polysaccharide Vaccine Revaccination

- Routine revaccination of immunocompetent persons is not recommended

- Revaccination recommended for persons 2–64 years of age who are at highest risk of serious pneumococcal infection

*MMWR* 2010;59(No.34):1102–5
Pneumococcal Polysaccharide Vaccine Candidates for Revaccination

- 5-year interval (2–64 years) with additional dose after 65th birthday, 5 years after previous dose:
  - Functional or anatomic asplenia (including sickle cell disease)
  - Immunosuppression (including HIV infection)
  - Transplant
  - Chronic renal failure
  - Nephrotic syndrome
  - Generalized malignancy
  - Hematologic malignancy

- 1 dose is recommended after the 65th birthday, but only 1 dose recommended after 65th birthday

- Maximum 3 doses of PPSV23 in a lifetime

*MMWR* 2010;59(No.34):1102–5 and 2010;59(RR-11)
What Do You Think?

- A 6-year-old patient has sickle cell disease. Her immunization history includes a complete PCV13 series and PPSV23 at 4 years of age. Should PPSV23 be administered today?

  - Yes
  - No
Pneumococcal Polysaccharide (PPSV23) Vaccine Administration

- Administer PPSV23 vaccine via intramuscular (IM) or subcutaneous injection
  - Choose needle size based on route and patient age and/or size
  - IM Site*:
    - 2–3 years: Vastus lateralis muscle is preferred; deltoid muscle may be used if the muscle mass is adequate
    - 4 years and older: Deltoid muscle is preferred; vastus lateralis muscle may be used
  - Subcut site:
    - Subcutaneous tissue over the upper outer triceps of arm

- Administer at the same medical visit as other vaccines
  *Professional judgement should be used to determine the proper needle length and site. Factors influencing site include local reaction, number of vaccines to be administered, age, and muscle mass
PCV13 for Immunocompromised Adults*

- Adults 19 years of age or older with:
  - Immunocompromising conditions
  - Functional or anatomic asplenia
  - CSF leaks
  - Cochlear implants

- Those who have not previously received PCV13 or PPSV23 should receive a single dose of PCV13 followed by a dose of PPSV23 at least 8 weeks later, with a booster dose of PPSV23 5 or more years later for those with:
  - Immunocompromising conditions
  - Functional or anatomic asplenia

*MMWR. October 12, 2012;61(40):816–819
Pneumococcal Vaccination and Adults

- PCV13 and PPSV23 adult vaccination recommendations are divided between 2 age groups. Persons who are:
  - 19 through 64 years of age
  - 65 years of age and older

- Immunization recommendations for persons 19 through 64 years of age are based on risk, including those at:
  - High risk
  - Higher risk
  - Highest risk
High Risk for IPD

- Administer 1 dose of PPSV23 to adults 19 through 64 years of age at high risk for IPD
  - PCV13 is NOT indicated
- This includes persons with:
  - Pulmonary disease (including asthma)
  - Cardiac disease (excluding hypertension)
  - Liver disease (including cirrhosis)
  - Diabetes
  - Alcoholism
  - Smokers
  - Residents of a long-term care facility

1 dose PPSV23
Higher Risk for IPD

- Administer PCV13 and PPSV23 to adults 19 through 64 years of age at higher risk for IPD, including those with:
  - CSF leak
  - Cochlear implant

- Administer PCV13 followed by PPSV23 vaccine

MMWR 2015;64(34):944–47
Highest Risk for IPD

- Adults 19 through 64 years of age at highest risk for IPD, including those who:
  - Are immunocompromised (including HIV infection)
  - Have chronic renal failure or nephrotic syndrome
  - Are asplenic

- Administer PCV13 and 2 doses of PPSV23

PCV13 ➔ 8 weeks ➔ PPSV23 ➔ 5 years ➔ PPSV23

*MMWR 2015;64(34):944–47*
PCV13-type disease reduced to historically low levels among adults ≥65 years old through pediatric PCV13 use.

2014 PCV13 recommendation for all adults ≥65 years old: minimal impact on PCV13-type disease

PCV13 is safe and effective

Balancing this evidence ACIP recommends PCV13 based on shared clinical decision making for those ≥65 years old without:
- immunocompromising condition
- CSF leak
- cochlear implant.

ACIP still recommends all adults ≥65 years old should receive one dose of PPSV23
Persons Age 65 Years and Older:
PCV13 – Shared clinical decision-making
PPSV23 – recommended for all persons

- No history of pneumococcal vaccine

![Diagram](https://via.placeholder.com/150)

- Immunization history of PPSV23 at age 65 or older

*8 weeks if at higher or highest risk

*MMWR 2015;64(34):944–47*
Persons Age 65 Years and Older:
PCV13 – Shared clinical decision-making
PPSV23 – recommended for all persons

- Received PPSV23 before age 65 years

Separate doses of PPSV23 by at least 5 years

*8 weeks if at higher or highest risk

*MMWR 2015;64(34):944–47*
Vaccine Administration Errors
Pneumococcal Vaccines

- Frequent vaccine administration errors:
  - Wrong vaccine
    - PPSV23 to an infant
  - Schedule error:
    - More than 1 PPSV23 revaccination dose to immunocompetent at-risk persons
## Pneumococcal Vaccines
### Adverse Reactions

<table>
<thead>
<tr>
<th></th>
<th>PPSV23</th>
<th>PCV13</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local reactions</strong></td>
<td>30%–50%</td>
<td>5%–49%</td>
</tr>
<tr>
<td><strong>Fever, myalgia</strong></td>
<td>&lt;1%</td>
<td>24–35%</td>
</tr>
<tr>
<td><strong>Febrile seizures</strong></td>
<td>---</td>
<td>Rare:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1–14/100,000; with IIV 4–45/100,000</td>
</tr>
<tr>
<td><strong>Severe adverse reactions</strong></td>
<td>Rare</td>
<td>8% (local)</td>
</tr>
</tbody>
</table>
Pneumococcal Vaccines
Contraindications and Precautions

- Severe allergic reaction to vaccine component or following prior dose of vaccine

- Moderate or severe acute illness
Vaccine Storage and Handling

- Store PCV13 and PPSV23 vaccines in a refrigerator between 2°C–8°C (36°F–46°F)

- Store:
  - In the original packaging with the lids closed
  - In a clearly labeled bin and/or area of the storage unit—not next to each other

- Do not freeze the vaccine

Vaccine storage label examples
Available at www.cdc.gov/vaccines/hcp/admin/storage/guide/vaccine-storage-labels.pdf
Administering PCV13 and PPSV23 Vaccines

General Rules

- PCV13 and PPSV23 should not be administered during the same clinic visit
  - Either vaccine may be administered simultaneously with influenza vaccine

- Administer PCV13 before PPSV23 whenever possible
What Do You Think?

- A 70-year-old patient is immunosuppressed. Her immunization history includes PCV13 and PPSV23 administered on the same day at 65 years of age. Should PPSV23 be administered today?

  - Yes
  - No
4

Resources
Resources are being updated

- See https://www.cdc.gov/vaccines/vpd/pneumo/hcp/recommendations.html for updates soon