Introduction to Communicable Disease Surveillance and Investigation in North Carolina

January 2014
Vaccine-Preventable Diseases 1

Kristin M. Sullivan, MPH
Vaccine-Preventable Diseases 1

Session 1
• Introduction to vaccine-preventable diseases (VPDs)
• Pertussis
  – Clinical and epidemiological features
  – Vaccine benefits and limitations
  – Local health department investigations

Session 2
• Other VPDs
  – Varicella
  – Measles, mumps, rubella
  – Diphtheria, tetanus, polio
• Reporting VPDs in NC EDSS
Learning Objectives

1. Recognize public health significance of vaccine-preventable diseases (VPDs)
2. Describe the epidemiology of pertussis and its changing trends
3. Describe the basic steps in a pertussis case investigation
VACCINE-PREVENTABLE DISEASES
SESSION 1

Presented by: Kristin M. Sullivan, MPH
Vaccine-Preventable Diseases

- Anthrax
- Diphtheria
- Hepatitis A
- Hepatitis B
- *Haemophilus influenzae* type b
- Human Papillomavirus
- Influenza
- Japanese encephalitis
- Lyme Disease (not in US)
- Measles
- Meningococcal
- Monkeypox (smallpox vaccine)
- Mumps
- Pertussis
- Pneumococcal
- Polio
- Rabies
- Rotavirus
- Rubella
- Shingles (Herpes Zoster)
- Smallpox
- Tetanus
- Tuberculosis
- Typhoid
- Varicella (Chickenpox)
- Yellow Fever
# Impact of Vaccines

<table>
<thead>
<tr>
<th>Disease</th>
<th>20th Century Annual Morbidity</th>
<th>2011 Reported Cases</th>
<th>% Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallpox</td>
<td>29,005</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>21,053</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Pertussis</td>
<td>200,752</td>
<td>18,719</td>
<td>91</td>
</tr>
<tr>
<td>Tetanus</td>
<td>580</td>
<td>36</td>
<td>94</td>
</tr>
<tr>
<td>Polio (paralytic)</td>
<td>16,316</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Measles</td>
<td>530,217</td>
<td>220</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Mumps</td>
<td>162,344</td>
<td>404</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Rubella</td>
<td>47,745</td>
<td>4</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Congenital Rubella Syndrome</td>
<td>152</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

2011 Cases: MMWR. Summary of Notifiable Diseases — United States, 2011, July 5, 2013 / 60(53);1-117
Distribution of Measles Genotypes, 2011
VPDs Around the Globe

Alert Level 2, Practice Enhanced Precautions

Updated Polio in Somalia, Kenya, and Ethiopia
Updated September 05, 2013
According to the Global Polio Eradication Initiative, as of September 4, 2013, 160 cases of polio have been reported from Somalia since April 2013. These are the first wild poliovirus cases reported in Somalia since 2007. Also, 13 polio cases have been reported from Kenya. These are the first wild poliovirus cases confirmed in Kenya since July 2011. One case from July has been reported from the Somali Region of Ethiopia. This is the first wild poliovirus case reported in Ethiopia since 2008.
Read More >>

Updated Rubella (German Measles) in Japan
Updated September 04, 2013
As of August 21, 2013, 13,747 rubella cases have been reported in Japan during 2013.
Read More >>

Updated Rubella (German Measles) in Poland
Updated September 04, 2013
As of August 31, 2013, a total of 36,440 cases of rubella have been reported in Poland since the beginning of 2013. The entire country is affected.
Read More >>

Estimated Vaccination Coverage -- National Immunization Survey, United States, 2012

<table>
<thead>
<tr>
<th>Children Aged 19–35 months</th>
<th>≥1 MMR</th>
<th>≥4 DTaP</th>
<th>Combined series*</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Carolina</td>
<td>89.0</td>
<td>85.9</td>
<td>75.4</td>
</tr>
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</table>

* Includes ≥4 doses of DTaP, ≥3 doses of poliovirus vaccine, ≥1 doses of measles vaccine, full series of Hib (3 or 4 doses, depending on product), ≥3 doses of HepB, ≥1 doses of varicella vaccine, and ≥4 doses of PCV.

<table>
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<tr>
<th>Adolescents Aged 13-17 Years</th>
<th>≥2 MMR</th>
<th>≥ 1 Tdap</th>
<th>Hx. disease or ≥ 2 varicella vaccine</th>
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<tr>
<td>North Carolina</td>
<td>93.2</td>
<td>87.9</td>
<td>79.1</td>
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http://www.cdc.gov/vaccines/stats-surv/nis/default.htm
Importance of VPD Surveillance

- Document and monitor impact of vaccination program on disease incidence, morbidity and mortality
- Evaluate the effectiveness of prevention strategies
- Evaluate vaccine effectiveness under conditions of routine use
- Guide vaccination policies
- Inform future vaccine development
VPD Case Investigations

In vaccinated individuals, consider:

• Vaccine characteristics
  – What is the vaccine effectiveness?
  – Does immunity wane?

• Lab results
  – Are they interpretable?
  – Can they be used to rule in/out disease?

• Clinical picture
  – Do we expect a non-classic or modified presentation?
Suspected Cases: Questions to Ask

Clinical
- Signs & Symptoms?
  - Order of appearance
  - Type
  - Duration
- Testing performed?
  - Type
  - Results
- More likely clinical explanation for illness?

Epidemiological
- Immune status?
- Recent travel?
- Contact with traveler?
- Contacts with similar symptoms?
- More likely epidemiological explanation for illness?

✓ Has the case definition been met?
✓ Vaccine History
✓ Birth Year
✓ Serological Testing for Immunity
✓ Previous History of Disease
Summary

• VPDs are still a threat to public health
• High immunization rates are crucial
• Knowing vaccination status is important for:
  – Monitoring vaccine effectiveness
  – Interpreting clinical and laboratory findings
Pertussis (Whooping Cough)
## Impact of Vaccines

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2011 Cases: MMWR. Summary of Notifiable Diseases — United States, 2011, July 5, 2013 / 60(53);1-117
Pertussis

• Highly contagious respiratory infection
• Spread by coughing or sneezing
• >80% susceptible household contacts infected

Image: CDC
**Bordetella pertussis**

- Bacteria that cause pertussis
- Attach to the cilia in upper respiratory tract
- Release toxins, damage cilia and cause inflammation

*Image: CDC*
Pertussis: Epidemiology

- Mode of transmission: droplet
- Incubation period: 7 – 10 day (range 4 – 21 days)
- Infectious period: start symptoms – 3 weeks of cough or 5 days after treatment
## Common Pertussis Terms

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<th>Definition</th>
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<tr>
<td>Paroxysmal cough</td>
<td>Sudden uncontrollable “fits” or spells of coughing where one cough follows the next without a break for breath</td>
</tr>
<tr>
<td>Whoop</td>
<td>High-pitched noise heard when breathing in after a coughing spasm</td>
</tr>
<tr>
<td>Apnea</td>
<td>Transient cessation of respiration which might occur spontaneously or after a coughing spasm</td>
</tr>
<tr>
<td>Posttussive vomiting</td>
<td>Vomiting following paroxysms of cough</td>
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*Manual for the Surveillance of Vaccine-Preventable Diseases, Chapter 10: Pertussis (Jul 2011)*
# Stages of Pertussis

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<th>Stage</th>
<th>Length</th>
<th>Clinical Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catarrhal</td>
<td>1–2 weeks</td>
<td>Runny nose, mild cough</td>
</tr>
<tr>
<td>Paroxysmal</td>
<td>1–6 weeks, up to 10</td>
<td>Paroxysmal cough</td>
</tr>
<tr>
<td>Convalescent</td>
<td>Weeks to months</td>
<td>Less persistent cough; secondary infection</td>
</tr>
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</table>
Complications

• Infants at highest risk of complications
  – 2004 – 2008: 111 infant deaths
  – 83% in infants < 3 months old
  – >50% require hospitalization
  – 1% of hospitalized infants die

• Secondary bacterial pneumonia
  – Most common complication
Infant with Pertussis

Courtesy of the California Department of Health Services and Dr. James Cherry, UCLA from www.immunize.org
Pertussis in Infants

• Atypical symptoms
  – Catarrhal stage and cough minimal or absent
  – Whoop infrequent
  – Apnea (sometimes with seizures)
  – Sneezing
  – Gagging, choking, vomiting

Adapted from http://www.cdc.gov/vaccines/ed/ciinc/Pertussis.htm

Image: CDC
Pertussis in Vaccinated Individuals

• May be milder than in infants and young children

• Wide spectrum of presentation
  – Asymptomatic infections can occur
  – Mild cough
  – Severe illness and classic presentation

• Whoop uncommon

• Can still transmit disease and are often source to infants
Reported Pertussis Cases: 1922-2012*

- 48,129 cases in 2012*

*2012 data are provisional and subject to change

SOURCE: CDC, National Notifiable Diseases Surveillance System, Supplemental Pertussis Surveillance System, and passive reports to the Public Health Service (1922-1949)
Pertussis Cases Reported in North Carolina, 1993-2012*

*Data are preliminary and subject to change
Reported pertussis incidence by age group: 1990-2012*

*2012 data are provisional.

SOURCE: CDC, National Notifiable Diseases Surveillance System and Supplemental Pertussis Surveillance System
Pre-2014 Case Definition

Prolonged cough

One accessory symptom

Culture positive?

Cough ≥ 2 weeks?

- Paroxysms of coughing; OR
- Inspiratory “whoop”; OR
- Posttussive vomiting; OR

PCR positive OR
- Contact with a lab-confirmed (PCR or culture positive) case?

Confirmed

Probable

Not a Case
2014 Case Definition

Prolonged cough

One accessory symptom
Reasons for Increase

- Better diagnostic testing (PCR)
- Increased recognition and reporting
- Natural 3–5 year cycles
- New strains
- Waning immunity from DTaP/Tdap
Pertussis Vaccines

• DTP (1940s)
• DTaP (1990s)
  – Infants at 2, 4, 6 months (1997)
  – Toddlers at 15-18 months (1992)
  – Pre-school at 4-6 years (1992)
• Tdap (2005)
  – Children 7–10 who are not fully immunized against pertussis
  – Adolescents 11–18 (preferably at age 11–12)
  – Adults ≥19, especially if in close contact with infants
DTaP: Effectiveness and Duration

• DTaP efficacy 80%–85%*
  – Highly effective, but can’t rule out infection based on vaccination status

• Protection fades over time
  – General estimate 4–12 years
  – Recent studies suggest shorter duration with DTaP

*Following 3 doses
Tdap: Effectiveness and Duration

- Effectiveness ~70% in field observational studies
- Preliminary data suggest effectiveness wanes within 3–4 years among acellular recipients

Waning Immunity

• DTaP and Tdap protection wanes within 5 years
• Likely contributor to increasing incidence, especially among children 7–10
• Vaccine still remains best way to prevent pertussis
  – Decreased severity, duration, and infectivity with breakthrough cases
PERTUSSIS CASE INVESTIGATIONS
Laboratory Criteria for Diagnosis

• Positive *B. pertussis* culture or
• Positive polymerase chain reaction (PCR)
• Serological testing performed *with a CDC-validated test*
  – CDC
  – VPD Reference Labs
  – Few state public health labs
Pertussis Labs: No Perfect Test

Clinicians Want:
• High sensitivity (few missed cases)
• Rapid results

Health Departments Want:
• High specificity (few false positives)
• Confirm etiology
• Avoid “pseudo-outbreaks”
## Pertussis Labs: No Perfect Test

<table>
<thead>
<tr>
<th>Test</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCR</td>
<td>• Sensitive</td>
<td>• Vary in specificity</td>
</tr>
<tr>
<td></td>
<td>• Fast</td>
<td>• False positives</td>
</tr>
<tr>
<td>Culture</td>
<td>• Specific (100%)</td>
<td>• Slow</td>
</tr>
<tr>
<td></td>
<td>• Gold standard</td>
<td>• Low sensitivity</td>
</tr>
<tr>
<td>Serology</td>
<td>• Useful late in illness</td>
<td>• Commercial results not useful</td>
</tr>
<tr>
<td>DFA</td>
<td>• None</td>
<td>• Low sensitivity</td>
</tr>
</tbody>
</table>
Optimal Timing for Diagnostic Testing

http://www.cdc.gov/pertussis/clinical/diagnostic-testing/diagnosis-confirmation.html
PCR Precautions

• False negatives
  – Testing too late in illness
  – Improper specimen collection

• False positives
  – Testing patients without signs/symptoms
  – Contamination of swab with vaccine DNA
    • Best Practices for Health Care Professionals on the use of PCR for Diagnosing Pertussis (CDC Website)
Pertussis Labs: Key Points

• There is no perfect test
  – Diagnosis based on clinical history and lab results
• PCR should be used in addition to culture
  – Avoid “pseudo-outbreaks”
  – Appropriate PCR testing
• Limited role for serologies
Treatment

• Macrolides
  – Azithromycin
  – Clarithromycin
  – Erythromycin

• May modify course if given early

• Not recommended after 3 weeks of cough

• Consider for up to 6 weeks for:
  – Infants
  – Pregnant women
Case Investigation

• Ensure proper testing has been performed and treatment has been initiated

• Instruct cases to refrain from public activities and school/work until no longer infectious
  – Earliest of either:
    • 5 days after appropriate treatment or
    • 21 days after cough onset
Contact Investigation

• Identify contacts who have:
  – Had direct face-to-face contact
  – Shared the same confined space in close proximity for $\geq 1$ hour
  – Had direct contact with respiratory, oral or nasal secretion

• In high-risk settings, determination of contacts should be more inclusive
School Contacts

• Students (including, but not limited to):
  – Core group of close friends, social contacts, boyfriends
  – Students sitting next to the case in class, extra-curricular activities, field trips
  – Students who work closely together
  – Bus seatmates or carpool contacts
  – Same after school programs and sports

• Consider staff, aides, volunteers
Symptomatic Contacts

• Refer for evaluation
  – Testing
  – Treatment

• Instruct symptomatic contacts to refrain from public activities and school/work until no longer infectious or until pertussis has been ruled out
Post-Exposure Prophylaxis (PEP)

• Primary objective: Prevent death and serious complications in individuals at increased risk of severe disease

High-risk Groups

- Infants
- Women in 3rd trimester of pregnancy
- Individual with pre-existing health conditions

Images: CDC
PEP Recommendations

• All household contacts
• Contacts at high-risk or who will have close contact with someone at high-risk
  – Close contacts at high risk for severe illness
  – Close contacts who are themselves in close contact with a someone else at high risk for severe illness
  – All contacts in high risk settings that include infants aged <12 months or women in the third trimester of pregnancy

Vaccination status DOES NOT influence recommendations for PEP

http://www.cdc.gov/pertussis/outbreaks/PEP.html
Broader Use of PEP

• Consider in situations with
  – Small number of cases
  – Limited closed settings
  – No ongoing, community-wide outbreak

• Consultation with health department
Other Public Health Responses

• Vaccination
  – Ensure contacts are up-to-date on vaccination
  – Especially:
    • Adults in close contacts with infants
    • Healthcare workers

• Surveillance
  – Instruct asymptomatic contacts to monitor for symptoms
  – Conduct active surveillance for at least 42 days after cough onset of last case
Lab Results Unavailable

- **Strong suspicion of pertussis**
  - Identify and provide prophylaxis to close contacts

- **Low suspicion of pertussis**
  - Can delay identification until there is laboratory confirmation
  - Do NOT delay prophylaxis of infants and their household contacts
Summary

• Pertussis incidence is increasing
  – Likely related to shorter duration of immunity since switch to acellular vaccines
• Vaccination is still the best tool for prevention
• Public health response is to prevent death and serious complications in individuals at increased risk of severe disease
## Resources

<table>
<thead>
<tr>
<th>Reference</th>
<th>Edition / Date</th>
<th>Website</th>
</tr>
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</table>