Why Measles Matters

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What is Measles

• Febrile rash illness

• Most contagious of the vaccine preventable diseases

• Highly effective vaccine part of the routine immunization schedule
Clinical Presentation

- Rash ~14 days after exposure (range 7-21 days)
- Fever (up to 105°F)
- Cough, Coryza, and/or Conjunctivitis
Measles Rash

• Follows prodrome lasting 2-4 days

• Prodrome may include Koplick Spots

• Erythematous maculopapular eruptions
  – Spreads from head to trunk to extremities
  – Initially blanching

• Fades in order of appearance
## Measles Complications

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percent reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>8</td>
</tr>
<tr>
<td>Otitis media</td>
<td>7-9</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1-6</td>
</tr>
<tr>
<td>Encephalitis</td>
<td>0.05-0.1</td>
</tr>
<tr>
<td>Death</td>
<td>0.1-0.2</td>
</tr>
<tr>
<td>Subacute Sclerosing Panencephalitis (SSPE)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

(2-15 in developing countries)
Global Burden of Measles

• Prior to Vaccine: 5-8 million deaths/year
• 77% decrease in incidence from 2000 to 2012
• 78% decrease in deaths from 2000 to 2012 (90% since 1985)
  – 122,000 deaths in 2012 (~14 deaths/hour)
• Remains a leading cause of Vaccine Preventable Deaths in young children
  – Most deaths in children under 5 years old
Measles Disease Incidence by WHO Region

FIGURE. Reported measles incidence per million population, by World Health Organization region and worldwide, 2000–2011


Abbreviations: AFR = African; AMR = Americas; EMR = Eastern Mediterranean; EUR = European; SEAR = South-East Asia; WPR = Western Pacific.

* As a milestone to measles eradication, the World Health Organization has set a goal of reducing the global incidence of measles to <5 cases per million population by 2015.
Measles Case Distribution by Month and WHO Regions, 2008-2014

This is surveillance data, hence for the last month, the data may be incomplete.

SEAR: India is not included in this graph.

As of 27 May 2013, South Sudan has reassigned to the Africa region (AFR) from the Eastern Mediterranean region (EMR).

Data source: surveillance DEF file
Data in HQ as of 5 May 2014
Measles Outbreak, France, 2008-2011 (n>20,000)

Measles Outbreak, Quebec, Canada, 2011 (n=725)

Measles cases by month of rash onset
Philippines, 2009–2014*

*as of March 15, 2014
Source: National Epidemiology Center
Global transmission patterns of measles viruses from the Philippines, 2014
US Annual Disease Burden Prior to Vaccine

- 3-4 million estimated and ~ 500,000 reported cases
- 48,000 hospitalizations
- 4,000 encephalitis cases
- 450-500 deaths
Measles Cases, United States, 1962-2014*

*2014 case count preliminary as of May 16
Reported Measles Incidence
United States, 1992-2014*

*2014 case count preliminary as of May 16
Measles, United States, 2001-2014*

Age Specific Incidence

*2014 case count preliminary as of May 16
**Measles, United States, 2001-2014**

*Importations by WHO Region*

*2014 case count preliminary as of May 16*
<table>
<thead>
<tr>
<th>WHO Region</th>
<th># of cases</th>
<th>Countries of travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>African</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>1</td>
<td>Pakistan</td>
</tr>
<tr>
<td>European</td>
<td>4</td>
<td>Dubai/Germany/London (1), Republic of Georgia (1), Netherlands (1), France/Belgium</td>
</tr>
<tr>
<td>Americas</td>
<td>4</td>
<td>Brazil (1), Canada (2), Chile (1)</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>7</td>
<td>India (7)</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>29</td>
<td>China (2), Philippines (22), Singapore (1), Saipan (1), Vietnam (1), SE Asia/Philippines (1), Malaysia/Micronesia (1)</td>
</tr>
</tbody>
</table>
Most Measles Cases Result in Limited Transmission

2014: 80% with 1 or 2 chains of transmission, 4% with 10 or more
Measles, United States, 1996-Present*
(Importations indicated by hashed lines from 2001)

*2014 case count preliminary as of May 16
<table>
<thead>
<tr>
<th>Year</th>
<th>Outbreak Name</th>
<th>State</th>
<th>Cases #</th>
<th>Import Status</th>
<th>Genotype</th>
<th>Setting</th>
<th>1st &amp; last rash onsets</th>
<th>Duration</th>
<th>Median Age</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Tippecanoe County</td>
<td>IN</td>
<td>34</td>
<td>Imported (Romania)</td>
<td>D4</td>
<td>Church/household</td>
<td>5/16/2005 - 6/24/2005</td>
<td>6 weeks</td>
<td>12 y</td>
<td>9 mo - 49 y</td>
</tr>
<tr>
<td>2008</td>
<td>DuPage/Cook County</td>
<td>IL</td>
<td>30</td>
<td>Imported-virus</td>
<td>D4</td>
<td>Homeschool</td>
<td>5/17/2008 - 7/3/2008</td>
<td>7 weeks</td>
<td>10 y</td>
<td>8 mo - 43 y</td>
</tr>
<tr>
<td>2013</td>
<td>Stokes/Orange County</td>
<td>NC</td>
<td>23</td>
<td>Imported (India)</td>
<td>D8</td>
<td>Community</td>
<td>4/5/2013 – 5/7/2013</td>
<td>5 weeks</td>
<td>14 y</td>
<td>12 mo - 59 y</td>
</tr>
<tr>
<td>2013</td>
<td>Tarrant/Denton County</td>
<td>TX</td>
<td>21</td>
<td>Imported (Indonesia)</td>
<td>D9</td>
<td>Church</td>
<td>7/21/2013 – 8/21/2013</td>
<td>5 weeks</td>
<td>11 y</td>
<td>4 mos – 44 y</td>
</tr>
<tr>
<td>2011</td>
<td>Hennepin County</td>
<td>MN</td>
<td>21</td>
<td>Imported (Kenya)</td>
<td>B3</td>
<td>Shelter</td>
<td>2/15/2011 - 4/24/2011</td>
<td>10 weeks</td>
<td>23 m</td>
<td>3 mo – 51 y</td>
</tr>
<tr>
<td>2008</td>
<td>Brooklyn/Kings County</td>
<td>NYC</td>
<td>21</td>
<td>Imported (Israel, Belgium)</td>
<td>D4</td>
<td>Community</td>
<td>2/17/2008 - 4/25/2008</td>
<td>10 weeks</td>
<td>15 m</td>
<td>5 mo - 11 y</td>
</tr>
<tr>
<td>2014</td>
<td>Manhattan</td>
<td>NYC</td>
<td>20</td>
<td>Imported-virus</td>
<td>B3</td>
<td>Community</td>
<td>2/16/2014 – 3/24/2014</td>
<td>5 weeks</td>
<td>23 y</td>
<td>3 mo – 36 y</td>
</tr>
</tbody>
</table>

*as of May 16, 2014
**Measles outbreak response has a high economic burden in the U.S.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Number of cases (outbreaks)</th>
<th>Estimated public health cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>US</td>
<td>107 (16)</td>
<td>$2.7-5.3M</td>
</tr>
<tr>
<td>2011</td>
<td>Utah</td>
<td>13 (2)</td>
<td>&gt;$330,000</td>
</tr>
<tr>
<td>2008</td>
<td>California</td>
<td>12 (1)</td>
<td>$125,000</td>
</tr>
<tr>
<td>2008</td>
<td>Arizona</td>
<td>14 (1)</td>
<td>$800,000 (limited to cost for 2 hospitals to respond to 7 cases in their facilities)</td>
</tr>
<tr>
<td>2005</td>
<td>Indiana</td>
<td>34 (1)</td>
<td>$168,000</td>
</tr>
<tr>
<td>2004</td>
<td>Iowa</td>
<td>1</td>
<td>$142,000</td>
</tr>
</tbody>
</table>

*Public health and health care costs expended to control the spread of measles*
Measles U.S. 2014*

- 216 cases reported from 15 states including 15 outbreaks
  - 45 importations
    - 22 from the Philippines
    - 38 (85%) US residents
  - 96% cases import-associated
  - 38 cases (17%) hospitalized

- Cases in US residents (N=207)
  - 63% unvaccinated
  - 25% unknown vaccination status (90% of those adults)
  - 12% vaccinated (including 8% with 2 or more doses)
  - Among unvaccinated
    - 83% were personal belief exemptors
    - 6% unvaccinated travelers age 6-15 mos
    - 7% too young to be vaccinated

* Provisional reports to CDC through May 16, 2014
Measles Vaccine

- Available as Measles, Mumps, Rubella (MMR) in the U.S.
- Licensed in 1963 in the U.S.
- Combination MMR vaccine licensed in 1971
- Vaccine Effectiveness
  - 1-dose: ~93%
  - 2-dose: ~97%
ACIP Measles Vaccine Recommendation History

1963: Age 9 mos

1965: Age 12 mos

1967: Age 15 mos

1989: 2 doses (as MMR) @ age 15 mos & 4-6 yrs

1994: 2 doses (12-15 mos & 4-6 yrs)
Travel Recommendations for Measles

- Persons aged ≥12 months should receive 2 doses*
  - Includes providing a 2\textsuperscript{nd} dose to children prior to age 4-6 yrs
  - Includes adults** who have only received one routine dose in the past

- Children aged 6-11 months should receive 1 dose
  - If vaccinated at age 6-11 months, still need 2 subsequent doses at age ≥12 months

* 2nd dose of MMR should be administered at least 28 days after the 1\textsuperscript{st} dose
** Born in 1957 or later
Keys to Measles Prevention, Diagnosis, & Response

• Vaccine
  – Vaccine Rates
  – VE

• Diagnostics
  – Differential Diagnosis
  – Hx & PE
  – Lab testing

• Case Response
  – Reporting
  – Contact Investigation
  – Presumptive evidence of immunity
  – Isolation and Quarantine
  – Post Exposure Prophylaxis
MMR Vaccination Coverage
National Immunization Survey, U.S.

Coverage (%)

- MMR 1+ (19-35 mo)
- MMR 2+ (13-17 yr)


Coverage (%) values are consistently close to 90%.
Diagnosing Measles

- Consider measles in differential diagnosis of febrile rash illness
  - e.g. Kawasaki’s, Dengue

- Travel History or Exposure to Recent Travelers

- Documented Vaccine History

- Lab testing
  - Serology for IgM
  - Viral specimen (nasopharyngeal, oropharyngeal, or nasal swab) for PCR (and genotyping)
Public Health Response
(for confirmed and suspect cases)

• Respiratory isolation of cases
  – Infectious period 4 days prior through 4 days after date of rash onset

• Report to Health Department
  – Immediately notifiable to CDC (within 24 hours)
  – Contact CDC Quarantine Station if relevant travel
  – Enhanced Surveillance

• Contact investigation
Contact Investigation for Exposure to Measles

• Persons exposed during cases infectious period
  – Includes exposure to area 2 hours after case left

• Establish presumptive evidence of immunity for contacts

• Quarantine of contacts without presumptive evidence of immunity (through 21 days after exposure)

• Postexposure prophylaxis (PEP)
  – Vaccine or Immune globulin (IG)
<table>
<thead>
<tr>
<th>Routine</th>
<th>Students at post-high school educational institutions</th>
<th>Health-care personnel</th>
<th>International travelers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Documentation of age-appropriate vaccination with a live measles virus-containing vaccine:</td>
<td>(1) Documentation of vaccination with 2 doses of live measles virus-containing vaccine, or</td>
<td>(1) Documentation of vaccination with 2 doses of live measles virus-containing vaccine, or</td>
<td>(1) Documentation of age-appropriate vaccination with a live measles virus-containing vaccine:</td>
</tr>
<tr>
<td>–preschool-aged children: 1 dose</td>
<td>(2) Laboratory evidence of immunity, or</td>
<td>(2) Laboratory evidence of immunity, or</td>
<td>–infants aged 6–11 months: 1 dose</td>
</tr>
<tr>
<td>–school-aged children (grades K-12): 2 doses</td>
<td>(3) Laboratory confirmation of disease, or</td>
<td>(3) Laboratory confirmation of disease, or</td>
<td>–persons aged ≥12 months: 2 doses, or</td>
</tr>
<tr>
<td>–adults not at high risk: 1 dose, or</td>
<td>(4) Born before 1957</td>
<td>(4) Born before 1957 - should consider 2 doses</td>
<td>(2) Laboratory evidence of immunity, or</td>
</tr>
<tr>
<td></td>
<td>(4) Born before 1957</td>
<td></td>
<td>(3) Laboratory confirmation of disease, or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(4) Born before 1957</td>
</tr>
</tbody>
</table>

Presumptive Evidence of Immunity for Measles
Postexposure Prophylaxis (PEP)  
MMR Vaccine

• Administer within 72 hours of exposure
  – May return to normal activities (except health care settings)
  – Still monitor for symptoms
  – Can be given down to age 6 months
  – Be aware of possibility of vaccine rash
Postexposure Prophylaxis (PEP) Immune Globulin

• Administer within 6 days of exposure

• Recommended Dose
  – Intramuscular (IGIM): 0.5 mL/kg (max = 15 mL)
  – Intravenous (IGIV): 400 mg/kg

• Recommended for the following groups (risk of severe disease and complications)
  • Infants aged <12 months (IGIM)
  • Pregnant women without evidence of immunity (IGIV)
  • Severely immunocompromised patients (IGIV)
Does the Vaccine Really Work?

1,000 exposed
(90% vaccine coverage)

900 Vaccinated
(97% VE)

27 vaccinated cases

100 Unvaccinated
(90% attack rate)

90 unvaccinated cases

23% of cases vaccinated
Keys to Maintaining Elimination in the U.S.

- High 2-dose MMR vaccine coverage
- High quality surveillance
  - Rapid identification of and response to measles cases
  - Reportable within 24 hours per Council of State and Territorial Epidemiologists (CSTE) guidelines
- Aggressive outbreak control measures
- Information sharing tools (Epi-X, HAN)
Keeping Sight on the Successes

• Elimination Achieved & Maintained

• Vaccine Works, Disease Recognizable
  – Eradication Possible & Achievable

• Outbreaks are Limited (size & # of generations)
  – High Overall Vaccine Coverage
  – Rapid/Aggressive Public Health Response to (suspect) Cases
Measles Era Approaching Elimination

• Measles is due to Failure to Vaccinate

• Measles Elimination is a Global Problem

• Maintenance of Elimination is Resource Intensive
  – Maintaining vaccine coverage
  – Intensive case/contact investigations
  – Healthcare workers diagnostic skills
  – Advanced laboratory techniques
Summary of Measles Elimination in the U.S.

• Declared in the U.S. in 2000
  – Pan American Health Organization (PAHO) documenting for the Americas
• Huge Public Health Achievement
• Brings New Challenges
  – Case investigations very resource intensive
  – Continued global threat
  – Highly contagious
  – Clustering, accumulation, and aging of susceptibles
DISCUSSION