Measles

- Highly contagious viral illness
- Frequent and often fatal in developing areas
- No longer indigenous in the Western Hemisphere
Measles Clinical Features

- Incubation period
  10 - 12 days

- Prodrome
  - Stepwise increase in fever up to 105°F
  - Cough, coryza, conjunctivitis
  - Koplik spots

Koplik Spots
Measles Clinical Features

- **Rash**
  - 2 - 4 days after prodrome, 14 days after exposure
  - Maculopapular, may become confluent
  - Spreads from head to trunk to extremities
  - Persists 5-6 days
  - Fades in order of appearance

- **Transmission**
  - Respiratory droplets and aerosol (coughing, sneezing, close personal contact with infected nasal or throat secretions
  - Contagious 4 days before to 4 days after rash onset
# Measles Complications

More common in children <5 years and adults

<table>
<thead>
<tr>
<th>Complication</th>
<th>Counts</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>1 per 1,000 cases</td>
</tr>
<tr>
<td>Death</td>
<td>1 – 3 per 1,000 cases</td>
</tr>
<tr>
<td>Subacute Sclerosing Panencephalitis (SSPE)</td>
<td>1 per 100,000 cases</td>
</tr>
<tr>
<td></td>
<td>7 – 10 years after measles</td>
</tr>
</tbody>
</table>
Measles Annual Disease Burden in U.S. Decades Prior to Vaccine (1950s)

- 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 June 20
Measles, United States, 2001-2014*
Age Specific Incidence

*2014 case count preliminary as of June 20
Measles Elimination* in the U.S.

• Declared in 2000 and achieved due to:
  – High two-dose vaccine coverage
  – High quality measles surveillance and response
  – Improved measles control in the World Health Organization Region of the Americas

• Elimination does not mean “gone forever” - imported cases and limited spread occur every year

* Defined as interruption of continuous measles transmission for lasting > 12 months
Get Vaccinated: Prevent and Stop Measles Outbreaks

When measles happens anywhere in the world...

It can travel here and spread

Since measles is still common in many countries, unvaccinated travelers will continue to bring the disease into the U.S., and it can spread to other people.

Make sure you and your family members are up-to-date on your measles-mumps-rubella (MMR) vaccine, including before traveling internationally. Ask your doctor if everyone has received all recommended doses of MMR for best protection against measles.

www.cdc.gov/measles/importation-infographic.html
Measles Epidemiology U.S., 2001 - 2011

- Median 60 cases/year (range 37 to 220)
- Importations ~ 33/year, majority in U.S. residents
- ~ 25% of cases hospitalized
- 2 deaths in ~ 1,000 cases
- Incidence <1 case/million population
  - Highest age-specific incidence in infants, lowest in adults
- Vaccination status
  - 65% unvaccinated
  - 20% unknown vaccination status
  - 15% vaccinated
- 4 outbreaks/year (range 2 – 12)
  - Median size 6 cases (3 – 34 cases)
Measles 2011 - 2014

- **Reported cases - 220, 55, 189, 644**
  - Median 205
  - Mean 277

- **Importations and outbreaks**
  - 2011  80 importations  14 outbreaks  3–21 cases
  - 2012  21 importations  4 outbreaks  3–14 cases
  - 2013  54 importations  11 outbreaks  3–58 cases
  - 2014  60 importations  23 outbreaks  3–383 cases
Measles Cases

From January 1 to May 1, 2015, 169 people from 20 states and the District of Columbia were reported to have measles [AZ, CA, CO, DC, DE, FL, GA, IL, MA, MI, MN, NE, NJ, NY, NV, OK, PA, SD, TX, UT, WA]. Most of these cases [117 cases (70%)] are part of a large multi-state outbreak linked to an amusement park in California.

2015 Measles Cases in the U.S.
January 1 to May 1, 2015

The United States experienced a record number of measles cases during 2014, with 668 cases from 27 states reported to CDC’s National Center for Immunization and Respiratory Diseases (NCIRD). This is the greatest number of cases since measles elimination was documented in the U.S. in 2000.
Immunization and Respiratory Diseases (NCIRD). This is the greatest number of cases since measles elimination was documented in the U.S. in 2000.

**Measles Cases and Outbreaks**

January 1 to May 1, 2015

- **169 Cases** reported in 20 states and the District of Columbia: Arizona, California, Colorado, Delaware, Florida, Georgia, Illinois, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Nevada, Oklahoma, Pennsylvania, South Dakota, Texas, Utah, Washington
- **5 Outbreaks** representing 89% of reported cases this year

*Provisional data reported to CDC’s National Center for Immunization and Respiratory Diseases

- The majority of people who got measles were unvaccinated.
- Measles is still common in many parts of the world including some countries in Europe, Asia, the Pacific, and Africa.

www.cdc.gov/measles/cases-outbreaks.html
Measles
Keep Your Guard Up

- Any patient with fever and rash should be assumed to have measles until proven otherwise
  - Immediate isolation

- Be highly suspect of patients with fever and coryza and/or conjunctivitis, particularly if unvaccinated or international travel

- Be certain of your measles immunity status

MMWR 2013;62(RR-4)
<table>
<thead>
<tr>
<th>Composition</th>
<th>Live viruses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-dose efficacy</td>
<td>80% (mumps) to 95% (measles and rubella)</td>
</tr>
<tr>
<td>Duration of immunity</td>
<td>Lifelong</td>
</tr>
<tr>
<td>Schedule</td>
<td>2 doses</td>
</tr>
</tbody>
</table>

*Single antigen measles, mumps, rubella vaccines no longer available*
ProQuad (MMRV) Vaccine

- Combined measles, mumps, rubella, and varicella vaccine
- 7 to 8 times as much varicella vaccine virus as monovalent varicella vaccine
- Approved only for children 12 months through 12 years of age
MMR Vaccine Failure

- Some recipients do not respond to the first dose
- Failure rate varies by component
- Caused by antibody, damaged vaccine, recording errors
- Most persons with vaccine failure will respond to second dose
Prevention of Measles, Rubella, Congenital Rubella Syndrome, and Mumps, 2013

Summary Recommendations of the Advisory Committee on Immunization Practices (ACIP)
**Figure 1. Recommended immunization schedule for persons aged 0 through 18 years – United States, 2015.**

*(FOR THOSE WHO FALL BEHIND OR START LATE, SEE THE CATCH-UP SCHEDULE [FIGURE 2]).*

These recommendations must be read with the footnotes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars in Figure 1. To determine minimum intervals between doses, see the catch-up schedule (Figure 2). School entry and adolescent vaccine age groups are shaded.

<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>16-18 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hepatitis B</strong> (HepB)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
<td></td>
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</tr>
<tr>
<td><strong>Rotavirus</strong></td>
<td>1st dose</td>
<td>2nd dose</td>
<td>See footnote 2</td>
<td></td>
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</tr>
<tr>
<td><strong>Diphtheria, tetanus, &amp; acellular pertussis</strong> (DTaP&lt; 7 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
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</tr>
<tr>
<td><strong>Tetanus, diphtheria, &amp; acellular pertussis</strong> (Tdap&lt; 7 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
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</tr>
<tr>
<td><strong>Haemophilus influenzae type b</strong> (Hib)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>See footnote 5</td>
<td></td>
<td></td>
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<tr>
<td><strong>Pneumococcal conjugate</strong> (PCV13)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
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<tr>
<td><strong>Pneumococcal polysaccharide</strong> (PPSV23)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
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</tr>
<tr>
<td><strong>Inactivated poliovirus</strong> (IPV&lt; 18 yrs)</td>
<td>1st dose</td>
<td>2nd dose</td>
<td>3rd dose</td>
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<tr>
<td><strong>Influenza</strong></td>
<td>1st dose</td>
<td>2nd dose</td>
<td>See footnote 8</td>
<td></td>
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<td></td>
<td></td>
<td>Annual vaccination (IV only) 1 or 2 doses</td>
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</tr>
<tr>
<td><strong>Measles, mumps, rubella</strong> (MMR)</td>
<td>1st dose</td>
<td>2nd dose</td>
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<td></td>
<td></td>
<td></td>
<td>Annual vaccination (LAIV or IV) 1 dose only</td>
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<tr>
<td><strong>Varicella</strong></td>
<td>1st dose</td>
<td>2nd dose</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Annual vaccination (LAIV or IV) 1 dose only</td>
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<tr>
<td><strong>Hepatitis A</strong></td>
<td>1st dose</td>
<td>2nd dose</td>
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<tr>
<td><strong>Human papillomavirus</strong></td>
<td>3-dose series</td>
<td>females only: HPV2; males and females</td>
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<tr>
<td><strong>Meningococcal</strong></td>
<td>1st dose</td>
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</tr>
</tbody>
</table>

**NOTE:** The above recommendations must be read along with the footnotes of this schedule.
<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age Group</th>
<th>19-21 years</th>
<th>22-26 years</th>
<th>27-49 years</th>
<th>50-59 years</th>
<th>60-64 years</th>
<th>≥ 65 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza</td>
<td>1 dose annually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetanus, diphtheria, pertussis (Td/Tdap)³ ²</td>
<td>Substitute 1-time dose of Tdap for Td booster; then boost with Td every 10 yrs</td>
<td></td>
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</tr>
<tr>
<td>Varicella</td>
<td>2 doses</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Human papillomavirus (HPV) Female³ ³</td>
<td>3 doses</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Human papillomavirus (HPV) Male³ ³</td>
<td>3 doses</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Zoster³</td>
<td>1 dose</td>
<td></td>
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</tr>
<tr>
<td>Measles, mumps, rubella (MMR)² ²³</td>
<td>1 or 2 doses</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumococcal 13-valent conjugate (PCV13)³ ³</td>
<td>1-time dose</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Pneumococcal polysaccharide (PPSV23)³ ³</td>
<td>1 or 2 doses</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Meningococcal³</td>
<td>1 or more doses</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis A³ ³</td>
<td>2 doses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis B³ ³</td>
<td>3 doses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemophilius influenza type b (Hib)³ ³</td>
<td>1 or 3 doses</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Covered by the Vaccine Injury Compensation Program

For all persons in this category who meet the age requirements and who lack documentation of vaccination or have no evidence of previous infection: zoster vaccine recommended regardless of prior episode of zoster

Recommended if some other risk factor is present (e.g., on the basis of immuno-competent, occupational, lifestyle, or other indication)

No recommendation
MMR Vaccine Recommendations

- All children 12 months of age and older should receive 2 doses at least 28 days apart.
- Adults born in 1957 or later should receive 1 or more doses at least 28 days apart unless other evidence of immunity.
- A routine second dose of MMR vaccine at least 28 days apart is recommended for adults who are:
  - Post-high school students
  - Travelers
  - Healthcare personnel
- Persons who received inactivated (killed) measles vaccine or measles vaccine of unknown type during 1963–1967 should be revaccinated with 2 doses of MMR vaccine.
- Adults born before 1957 are generally presumed immune to measles.
MMR Vaccination Schedule

- First dose of MMR or MMRV at 12 to 15 months of age
  - 6 months (MMR only) for children who will be traveling outside the United States (does not count as one of 2 routinely recommended doses)

- Second dose of MMR or MMRV at 4 to 6 years of age

- Second dose of MMR may be given earlier than 4 to 6 years of age, especially if international travel is planned

- Second dose of MMR for adults born in 1957 or later who have only received 1 dose in the past and if international travel is planned
Minimum Intervals

- MMR - 2 doses of MMR can be separated by 4 weeks
- MMRV - 2 doses of varicella vaccine must be separated by at least 3 months for children younger than 13 years of age
Presumptive Evidence of Measles and Mumps Immunity

- Documentation of adequate vaccination
  - 1 dose of MMR vaccine for preschool-aged children and adults not at increased risk of exposure
  - 2 doses for school-aged children (i.e., grades K-12) and for adults at increased risk of exposure

- Laboratory evidence of immunity

- Laboratory confirmation of disease

- Birth before 1957
MMR Serologic Testing

- Serologic testing after vaccination is not recommended
  - More than 99% immune after 2 doses*
  - Negative titer may not indicate susceptibility

- ACIP does not recommend more than 2 doses of MMR for anyone regardless of the results of serologic testing

*88% for mumps component
MMR Vaccine
Contraindications and Precautions

- Severe allergic reaction to vaccine component or following prior dose
- Pregnancy
- Immunosuppression
- Moderate or severe acute illness (precaution)
- Recent blood product (precaution)
Measles and Mumps Vaccines and Egg Allergy

- Measles and mumps viruses grown in chick embryo fibroblast culture
- Studies have demonstrated safety of MMR in egg-allergic children
- Vaccinate without testing
Vaccination of Women of Childbearing Age

- Ask if pregnant or likely to become so in next 4 weeks*
- Exclude those who say "yes"
- For others
  - Explain theoretical risks
  - Vaccinate

*Package insert states 3 months
MMR Vaccine and Imunosuppressive Therapy

- Low-dose steroids
  - Vaccinate anytime

- Leukemia in remission without chemotherapy for 3 months
  - Vaccinate
<table>
<thead>
<tr>
<th>Reaction</th>
<th>Percentage/Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>5%-15% (measles)</td>
</tr>
<tr>
<td>Rash</td>
<td>5% (measles)</td>
</tr>
<tr>
<td>Joint symptoms</td>
<td>25% (rubella)</td>
</tr>
<tr>
<td>Thrombocytopenia</td>
<td>&lt;1/30,000 doses (measles)</td>
</tr>
<tr>
<td>Parotitis</td>
<td>rare (mumps)</td>
</tr>
<tr>
<td>Deafness</td>
<td>rare (mumps)</td>
</tr>
<tr>
<td>Encephalopathy</td>
<td>&lt;1/1,000,000 doses (measles)</td>
</tr>
</tbody>
</table>
Vaccine Storage and Handling
MMR Vaccine

- Store 35°F - 46°F (2°C - 8°C) (may be stored in the freezer)
- Store diluent at room temperature or refrigerate
- Protect vaccine from light
- Discard if not used within 8 hours after reconstitution
Measles-containing Vaccine and Tuberculin Skin Testing (TST)

- Measles disease can cause a person with a latent tuberculosis infection to develop active TB
- Measles vaccine does not exacerbate TB
- TB testing is not a prerequisite for MMR vaccination
Measles-containing Vaccine and Tuberculin Skin Testing (TST)

- Apply TST at same visit as vaccine (preferred)
- Apply TST first - administer vaccine when skin test read (least preferred)
- Delay TST at least 4 weeks if MMR administered first
Measles Postexposure Prophylaxis

- Expanded recommendations for use of immune globulin administered intramuscularly (IGIM) to include infants aged birth to 6 months exposed to measles
- Increased the recommended dose of IGIM for immunocompetent persons
- Recommended use of immune globulin administered intravenously (IGIV) for severely immunocompromised persons and pregnant women without evidence of measles immunity who are exposed to measles
Measles Resources

- Measles 2015: Situational Update, Clinical Guidance, and Vaccination Recommendations
  http://emergency.cdc.gov/coca/calls/2015/callinfo_021915.asp

- Health Alert Network (HAN) No. 376 - U.S. Multi-state Measles Outbreak, December 2014-January 2015
  http://emergency.cdc.gov/han/han00376.asp
Measles, Mumps, Rubella Resources

- ACIP’s Measles, Mumps, Rubella Recommendations web pages
  - www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/mmr.html
  - www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/mmrv.html

- CDC’s Measles, Mumps, Rubella Infection web pages
  - www.cdc.gov/measles/index.html
  - www.cdc.gov/mumps/index.html
  - www.cdc.gov/vaccines/vpd-vac/rubella/default.htm#disease

- CDC’s Measles, Mumps, Rubella Vaccination web pages
  - www.cdc.gov/vaccines/vpd-vac/measles/default.htm
  - www.cdc.gov/vaccines/vpd-vac/mumps/default.htm
  - www.cdc.gov/vaccines/vpd-vac/rubella/default.htm
Measles Update 2015: Implications for the College Setting

Jennifer Zipprich, PhD
Epidemiologist, Immunization Branch
California Department of Public Health
Outline

• Descriptive epidemiology of the measles outbreak in California that started in December 2014

• Steps in a measles case/contact investigation

• Preparedness for measles on a college campus
Confirmed Measles Cases, California 2000 - 2014
Identifying the Outbreak

• January 5\textsuperscript{th}, CDPH was notified of a suspect measles case in an unvaccinated 11 yo whose only notable travel was to Disneyland

• On the same day CDPH was notified of two measles suspects from Utah, and four additional suspect cases with travel to Disneyland or California Adventure Park during their exposure period

• By January 7\textsuperscript{th}, 7 cases had been confirmed and CDPH initiated notifications to other states
Measles Associated with a Theme Park?

- Disneyland and California Adventure Park have over 24M visitors annually, many from international destinations where measles is endemic.

- This is not the first time Disneyland has been implicated in a measles outbreak. Report from 1982:

  **Measles outbreak linked to Disneyland**

  ANAHEIM, Calif. (AP) — Public health officials say at least 34 cases of measles in California, Arizona, Oregon and Texas have been traced to 20 children who visited Disneyland on Aug. 17 or 18.
  The 20 children transmitted the disease to 14 other people, and there may be additional unreported cases, according to Russ Charter of the California Department of Health Services. He said the disease may spread now that school has opened.
California Counties Reporting Measles Cases, December 2014 – April 17th, 2015, n=131

<table>
<thead>
<tr>
<th>County</th>
<th>Total number of confirmed cases</th>
<th>City of Long Beach*</th>
<th>City of Pasadena*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALIFORNIA</td>
<td>131</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALAMEDA</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Long Beach*</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Pasadena*</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MARIN</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MERCED</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORANGE</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIVERSIDE</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAN BERNARDINO</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAN DIEGO</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAN MATEO</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SANTA CLARA</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOLANO</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VENTURA</td>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*City health jurisdictions not included in county total
Epidemiologic Data

- Data are preliminary

- Confirmed cases meet the CSTE case definition for measles

- Outbreak cases are those with B3 genotype or for which there are epidemiologic evidence (linkage, time, place) and for whom alternative measles exposures cannot explain their illness
  - Non-B3 cases are not shown
## Transmission Setting/Source

<table>
<thead>
<tr>
<th>Transmission setting</th>
<th>Cases</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disney primary case - Visited Disney from December 17th - December 20th</td>
<td>42</td>
<td>32%</td>
</tr>
<tr>
<td>Household or close contact of a confirmed case</td>
<td>31</td>
<td>24%</td>
</tr>
<tr>
<td>Community setting where confirmed case was known to be present*</td>
<td>14</td>
<td>11%</td>
</tr>
<tr>
<td>Unknown</td>
<td>44</td>
<td>34%</td>
</tr>
</tbody>
</table>
Vaccination Status

- 81 patients had immunization status verified
- The majority of these are unvaccinated
- Majority of unvaccinated were unvaccinated due to personal beliefs

<table>
<thead>
<tr>
<th></th>
<th>Total*</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unvaccinated</td>
<td>57</td>
<td>70%</td>
</tr>
<tr>
<td>Vaccinated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 dose</td>
<td>10</td>
<td>12%</td>
</tr>
<tr>
<td>2 doses</td>
<td>13</td>
<td>16%</td>
</tr>
<tr>
<td>3 doses</td>
<td>2</td>
<td>2%</td>
</tr>
</tbody>
</table>

*49 cases have unknown or unverified vaccination status

One dose of MMR vaccine is 92% effective at preventing measles
Two doses of MMR vaccine are 97% effective at preventing measles
Do measles cases occur in vaccinated people?

930 have received two doses of MMR vaccine

1000 people exposed to measles

70 are unvaccinated

2 doses MMR vaccine 97% effective

90% attack rate among susceptibles

25 vaccinated cases

63 unvaccinated cases

25/88 or 28% of cases are vaccinated
Age Distribution and Hospitalization Status

- Majority of cases are in adults
- Higher incidence among < 1 yo
- % hospitalized is lower than in typical years

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Total</th>
<th>Incidence per 100,000 population*</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>14</td>
<td>2.67</td>
<td>11%</td>
</tr>
<tr>
<td>1-4</td>
<td>21</td>
<td>1.05</td>
<td>16%</td>
</tr>
<tr>
<td>5-19</td>
<td>24</td>
<td>0.31</td>
<td>18%</td>
</tr>
<tr>
<td>20-29</td>
<td>30</td>
<td>0.54</td>
<td>23%</td>
</tr>
<tr>
<td>30-39</td>
<td>21</td>
<td>0.40</td>
<td>16%</td>
</tr>
<tr>
<td>40-49</td>
<td>10</td>
<td>0.19</td>
<td>8%</td>
</tr>
<tr>
<td>50-59</td>
<td>9</td>
<td>0.18</td>
<td>7%</td>
</tr>
<tr>
<td>60-69</td>
<td>1</td>
<td>0.03</td>
<td>1%</td>
</tr>
<tr>
<td>70+</td>
<td>1</td>
<td>0.03</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Population denominator data from the Department of Finance have been standardized with 2010 Census data

<table>
<thead>
<tr>
<th></th>
<th>Total*</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospitalized</td>
<td>21</td>
<td>20%</td>
</tr>
<tr>
<td>Not hospitalized</td>
<td>84</td>
<td>80%</td>
</tr>
</tbody>
</table>

*26 have missing hospitalization data
Confirmed Measles Cases* by Rash Onset Date and Transmission Setting, California, December 2014 - April 17th, 2015

- Unknown source
- Community contact to a case
- Household or close contact of a case
- Exposed at Disneyland Dec 17th-Dec 20th

*Outbreak declared over on 4/17/2015
Data on Clusters

- > 20 clusters
  - Largest has 7 cases

- 51% of the cases in the outbreak occur in cluster

- 43% of clustered cases got measles from a household/household-type exposure
Measles Testing

• PCR testing for measles was the primary diagnostic tool in this outbreak
  – Viral and Rickettsial Disease Laboratory (VRDL) offers measles PCR testing of urine and respiratory specimens
  – 17 local public health laboratories offer PCR testing
• VRDL performed > 1500 PCR tests; local public health laboratories performed > 900 PCR tests
• VRDL performed genotyping
  – 73 genotype B3
  – Other genotypes that occurred during the outbreak (but not associated): D4 (1), D8 (2), H1 (2), A (30)
From January 1 – April 17, 2015, 162 people from 19 states.
Final Outbreak Thoughts

- Source for the outbreak has not been identified

- Onset date for the last confirmed case March 2, 2015

- April 17th was two incubation periods past the last infectious day for this case = the outbreak in California is over
College Campuses and the Risk of Imported Measles

• International students from measles endemic regions
  – 868,000 in 2013-2014
• U.S. students study and travel abroad
  – 289,000 studied abroad in 2012-2013
• NHANES suggests high level of population immunity to measles in current college cohort
  – In the U.S. 2 dose MMR recommendation was made in 1989
  – NHANES data see no difference between population immunity in U.S. born versus foreign born (could vary by age)
# International Students Enrolled in U.S. Universities: Top 10 Countries of Origin

<table>
<thead>
<tr>
<th>Rank</th>
<th>Place of Origin</th>
<th>Number of Students</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>274,439</td>
<td>31.0%</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>102,673</td>
<td>11.6%</td>
</tr>
<tr>
<td>3</td>
<td>South Korea</td>
<td>68,047</td>
<td>7.7%</td>
</tr>
<tr>
<td>4</td>
<td>Saudi Arabia</td>
<td>53,919</td>
<td>6.1%</td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>28,304</td>
<td>3.2%</td>
</tr>
<tr>
<td>6</td>
<td>Taiwan</td>
<td>21,266</td>
<td>2.4%</td>
</tr>
<tr>
<td>7</td>
<td>Japan</td>
<td>19,334</td>
<td>2.2%</td>
</tr>
<tr>
<td>8</td>
<td>Vietnam</td>
<td>16,579</td>
<td>1.9%</td>
</tr>
<tr>
<td>9</td>
<td>Mexico</td>
<td>14,779</td>
<td>1.7%</td>
</tr>
<tr>
<td>10</td>
<td>Turkey</td>
<td>13,286</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td>All Others</td>
<td>273,426</td>
<td>30.9%</td>
</tr>
</tbody>
</table>

Source: Institute of International Education, *Open Doors Report*
# Top 10 Destinations for U.S. Study Abroad Students 2012-2013

<table>
<thead>
<tr>
<th>Rank</th>
<th>Destination</th>
<th>2012/13</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United Kingdom</td>
<td>36,210</td>
<td>12.5</td>
</tr>
<tr>
<td>2</td>
<td>Italy</td>
<td>29,848</td>
<td>10.3</td>
</tr>
<tr>
<td>3</td>
<td>Spain</td>
<td>26,281</td>
<td>9.1</td>
</tr>
<tr>
<td>4</td>
<td>France</td>
<td>17,210</td>
<td>5.9</td>
</tr>
<tr>
<td>5</td>
<td>China</td>
<td>14,413</td>
<td>5.0</td>
</tr>
<tr>
<td>6</td>
<td>Germany</td>
<td>9,544</td>
<td>3.3</td>
</tr>
<tr>
<td>7</td>
<td>Costa Rica</td>
<td>8,497</td>
<td>2.9</td>
</tr>
<tr>
<td>8</td>
<td>Australia</td>
<td>8,320</td>
<td>2.9</td>
</tr>
<tr>
<td>9</td>
<td>Ireland</td>
<td>8,084</td>
<td>2.8</td>
</tr>
<tr>
<td>10</td>
<td>Japan</td>
<td>5,758</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Total U.S. study abroad students: 289,408
Notable International Outbreaks

Largest outbreaks
The US outbreak that sparked the recent debate over vaccination is tiny compared with ones elsewhere.

- = 100 cases

2012
- 15,489 Indonesia
- 18,668 India
- 72,029 DRC

2013
- 26,883 China
- 52,852 Nigeria
- 88,381 DRC

2014
- 17,267 Vietnam
- 121 United States
- 57,564 Philippines
- 107,024 China

Number of Reported Measles Cases with onset date from Oct 2014 to Mar 2015 (6M period)

Data source: surveillance DEF file
Data in HQ as of 4 May 2015

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement. ©WHO 2015. All rights reserved.
### Measles Outbreaks Around the World

- **China** is reporting > 50,000 suspect and confirmed measles cases in 2015.
- **Germany** has reported > 950 cases of measles in 2015. One child has died.
- **Kyrgyzstan** is experiencing an ongoing measles outbreak with > 7,400 measles cases. Two children have died.
- **Ethiopia** is experiencing an ongoing measles outbreak with > 14,000 confirmed cases in 2014; cases continue to occur in 2015.
- **Angola** is experiencing an ongoing measles outbreak. With > 12,036 in 2014; cases continue to occur in 2015.
- **The Federation of Bosnia and Herzegovina** has reported > 3,800 measles cases since January 2014.
- **Vietnam** > 18,597 suspected measles cases, including 6,498 confirmed cases, and no deaths during 2014.
- **Philippines** > 58,010 suspected cases of measles, including 21,420 confirmed cases and 110 deaths in the Philippines during 2014.

Published by Oxford University Press on behalf of the Infectious Diseases Society of America 2015. This work is written by (a) US Government employee(s) and is in the public domain in the US.
Framework for Thinking about Measles Investigations on a College Campus

- Exposures in the community
- Exposures on campus
- Exposures in healthcare settings (campus and/or community)
Measles Investigations on a College Campus

• Student health services (SHS) role is multi-faceted when measles cases and exposures occur on campus
  – Coordinating specimen collection
  – Following up with contacts
  – Coordinating quarantine and isolation
  – Communications to students
  – Administering post-exposure prophylaxis
  – Vaccination clinics

• Close collaboration with state/local public health
Identifying a Suspect Measles Case

Measles should be considered in persons with rash and fever

• Rash starts on face and descends
  – Rash may not descend to extremities in patients with 2 MMR but the appearance and direction of spread remain consistent with classic illness

• Patients are ill appearing
  – Vast majority report fever over 101, cough, and coryza
  – Patients with 2 MMR may have modified illness

• Do not rule out measles based on age or vaccination status
### Measles Symptoms by Immunization Status - Orange County, 2014-2015

<table>
<thead>
<tr>
<th></th>
<th>Not vaccinated (n=20)</th>
<th>Vaccinated/ serologic proof of immunity (n=10)</th>
<th>Unknown Vaccination Status (n=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>100%</td>
<td>80%</td>
<td>92%</td>
</tr>
<tr>
<td>Cough</td>
<td>83%</td>
<td>50%</td>
<td>73%</td>
</tr>
<tr>
<td>Coryza</td>
<td>89%</td>
<td>55%</td>
<td>62%</td>
</tr>
<tr>
<td>Koplik spots</td>
<td>38%</td>
<td>25%</td>
<td>0%</td>
</tr>
<tr>
<td>Conjunctivitis</td>
<td>72%</td>
<td>33%</td>
<td>42%</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>11%</td>
<td>30%</td>
<td>8%</td>
</tr>
<tr>
<td>Rash duration</td>
<td>6 days (4-8d)</td>
<td>4.5 days (4-6d)</td>
<td>5 days (2-9d)</td>
</tr>
<tr>
<td>Hospitalized</td>
<td>20%</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>LOS</td>
<td>3-4 d</td>
<td>2-5 d</td>
<td>1-6 d</td>
</tr>
<tr>
<td>Otitis</td>
<td>11%</td>
<td>0%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Identifying a Suspect Measles Case

• Patients with rash and fever should be queried about:
  – Travel history in past 21 d
  – Contact with international travelers in past 21 d
  – Venues with international travelers (international airports, tourist destinations)
  – Contact with persons with rash in past 21 d
  – Vaccination status

• A note on travel:
  – Measles circulates everywhere outside of North and South America
You Think You Have a Suspect Measles Case – What Next?

• Report the suspect measles case to your local/state public health department
  – Your state/local health department will advise you of local resources and provide local guidance
  – CSTE lists measles as immediate, urgent and requires notification to CDC within 24 hours

• Collect specimens for testing

• Make arrangements for isolation
  – If the patient resides in university housing attempts to relocate student to accommodations where they can be appropriately isolated should be taken
  – Patient should be isolated until measles is ruled out or until four days after rash onset if measles is confirmed
Releasing Case Information: FERPA and Public Health

• When can health information about a student, including a reportable disease, be released without consent?

• FERPA includes a statutory exception for non-consensual disclosures made “in connection with an emergency,” to “appropriate persons if the knowledge of such information is necessary to protect the health or safety of the student or other persons.”

• Consult with your University’s legal staff for their interpretation
Measles Testing

• Measles IgM and IgG
  – Serum
  – Widely available at commercial laboratories

• Measles polymerase chain reaction (PCR)
  – Urine, respiratory specimen
  – Available in many state public health laboratories and at CDC
Measles Testing - Serology

• False positives are common
  – Rheumatoid factor, Pregnancy, incomplete immunodepletion of IgG

• False negatives can also occur
  – In 10 vaccinated patients: 5 IgM negative, 3 IgM positive, 2 Not Done; All 9 tested were PCR positive
  – Blood specimens collected within 72 hours of rash onset may be falsely negative
Measles Testing - PCR

- PCR testing to detect measles virus is preferred for several reasons
  - Virus can be detected in respiratory (<= 7 days after rash) or urine specimens (<= 10 days after rash), which are easy to collect and non-invasive
  - High sensitivity and specificity; virus can be detected on day of rash onset
  - Test is rapid (TAT < 1 day) and high throughput
  - Additional testing to identify genotype can be performed
Measles Testing: Bottom Line

• PCR > serology
  – If a case is identified retrospectively serology may be more appropriate

• Important to maintain appropriate testing practices
  – Avoid false positives

• Interpretation of testing can be complicated; the complete picture should be taken into consideration (timing of specimen collection, clinical, potential exposures)
Identifying Exposed Contacts

• The patient is interviewed by public health to determine their whereabouts while infectious
  – Infectious period is 9 days total
• Public health works with healthcare or other facilities to identify and follow-up with exposed contacts
• For exposures in settings where individual cases cannot be identified, postings or press releases may be used to notify the public
Identifying Exposed Contacts

• Standard definition: Anyone who has shared the same airspace with a patient infectious with measles up to 2 hours after the patient has left the space

• Refer to your state’s guidance on identifying exposed persons
  – In California, anyone who has shared the same airspace with a patient infectious with measles up to 1 hour
Considerations for Exposures that Occur in Student Health Clinics

• Establish a method for identifying what staff and students were in the facility at the same time as an infectious patient

• If your clinic shares a building with other office/classroom spaces, work with building engineer to determine airflow/circulation

• Measles IgG seropositivity or documentation of 2 MMR is not 100% effective at preventing measles
  – Healthcare workers should still wear an N95 mask when seeing a suspect measles patient
  – Healthcare workers who have been exposed to measles and are considered immune should still monitor for symptoms
Non-healthcare
Exposures on Campus

• When contacts can be identified, follow up with them individually
  – Classroom, dorms, friends/close contacts, etc.
• Often exposures occur in public areas on campus and email communication can be used to broadly notify students about the exposure
• Some universities maintain student vaccination records
  – Are these records easily accessible, can they be quickly queried?
• Although students may have immunization records available, staff will not
Contact Follow-up

- Assess measles immune status
- Provide post-exposure prophylaxis, if indicated
  - MMR within 72 hours of exposure
  - IGIV within 6 days of exposure for severely immunocompromised or pregnant persons without evidence of immunity
- Perform measles IgG testing of contacts if immunity cannot be established in any other way
- Perform measles testing of contacts who develop a rash
Considerations Relevant to SHS

- Quarantine accommodations may be required for exposed students who cannot demonstrate measles immunity

- Maintain infection control procedures for exposed contacts:
  - Who request measles IgG testing
  - Become symptomatic with measles symptoms
Satellite Testing Site in Orange County

- Outdoor clinic under a canopy
- One medical assistant
- One office technician
- Testing of suspect cases who had already been assessed by a medical provider
- Tests performed included:
  - Oropharyngeal PCRs
  - Serum IgM
MMR Vaccination in an Outbreak: Varying Options

- MMR can be administered within 72 hours of an exposure to serve as post-exposure prophylaxis

- In students with one dose of MMR, a second dose can be given anytime 28 days after the first dose

- In exposed persons who have documentation of 2 doses of MMR, measles IgG testing is not necessary
MMR Vaccination During an Outbreak: Considerations

- Vaccination is the most important and effective tool that we have to stop measles outbreaks but keep in mind:
  - Approximately 5% of recipients will experience rash and fever
  - When tested, vaccine recipients will be PCR positive for measles
  - Genotyping can discriminate between vaccine strain and wild type virus but can take 1 week or more to perform
Patient with rash and fever presents to clinic

• Rapid assessment of contacts
• Administer PEP
• Quarantine
• High level of population immunity!!

Patient is diagnosed with measles

• Healthcare workers protected
• Prompt identification, testing and isolation

Contact Follow-up

• Rapid identification of contacts
Preparedness Checklist

- Contact your local/state health department to become familiar with local testing resources and guidances for measles
- Establish infection control procedures in your student health clinic to minimize measles exposures
  - Train staff to identify suspected measles cases and implement infection control procedures
  - Post signs to let patients with rash and fever know to alert clinic staff immediately
Preparedness Checklist

✓ Ensure that SHS staff meet requirements for measles immunity established HICPAC
✓ Ensure that SHS staff are fit-tested for N95 respirators
✓ Identify accommodations on campus that could be used for isolation and quarantine
✓ Determine how to access student immunization records
✓ Ensure that students traveling or studying abroad have received 2 doses of MMR
ATTENTION: YOU COULD HAVE MEASLES.

If you have:

- a fever
- a rash
- traveled overseas in the last 3 weeks

Tell Staff and Get a Mask.
Protect Yourself and Others Now!

Measles is very contagious and is widespread in many parts of the world.
VISITING ANOTHER COUNTRY? PROTECT YOUR FAMILY.

THINK MEASLES.

Measles is widespread in places like Europe, Africa, Asia, India, and the Philippines.

BEFORE YOU TRAVEL
Tell your doctor where you are traveling. Babies and children may need measles protection at a younger age than usual.

AFTER YOU TRAVEL
Call your doctor if anyone gets a fever and rash within 3 weeks of returning from your trip. Describe where you traveled.

Talk with your doctor if you are planning an international trip.
For more information go to www.cdc.gov/travel.

California Department of Public Health, Immunization Branch

IMM-1048 (5/11)
Measles Resources
(Check with your state for local resources)

- Keep up with U.S. measles cases and outbreaks:
  http://www.cdc.gov/measles/cases-outbreaks.html
- Vaccination recommendations:
  http://www.cdc.gov/measles/vaccination.html
- California Measles Investigation Quicksheet:
- California Measles Laboratory Testing Quicksheet:
- Browse all of California’s measles resources at:
  http://www.cdph.ca.gov/HealthInfo/discond/Pages/Measles.aspx
Acknowledgements

- California Local Health Jurisdictions
- California Department of Public Health, Immunization Branch, Epidemiology Section
- California Department of Public Health, Viral and Rickettsial Disease Laboratory
- Centers for Disease Control and Prevention
Questions?

Jennifer.zipprich@cdph.ca.gov
510-620-3848