Measles basics

Measles or Rubeola or Hard Measles or Red Measles.
- Paramyxovirus, Morbillivirus: RNA, protein, lipid.
- First described in 910 AD in Baghdad.
- Formerly a “childhood disease”.
- One of the most highly contagious diseases.
- Still kills about a million people a year globally.
- Transmission: direct contact, droplets, airborne.
- Incubation period: 10 days (7-21 days).
- Communicability period: 4 days before rash onset to 4 days after rash appearance.
- Life-long immunity after disease or immunization.

Measles signs and symptoms

Measles typically begins with
- High fever,
- Cough,
- Runny nose (coryza), and
- Red, watery eyes.
- 2-3 days after symptoms begin, tiny white spots (Koplik spots) may appear inside the mouth.
- 3-5 days after symptoms begin, a rash appears.

Measles rash

Measles rash
- Rash begins on face and proceeds down the body to involve the extremities last, including palms and soles.
- Erythematous and maculopapular, may become confluent.
- Rash lasts about 5 days.
- Maculopapular rash contains both macules and papules. A macule is flat discolored skin, and a papule is a small raised bump. A maculopapular rash is usually a large area that is red, and has small, confluent bumps.

Treatment
- No specific treatment.
- Supportive care: Maintain hydration, control fever.
- Vitamin A.
Characteristic red blotchy rash during third day of the measles rash

Measles Laboratory Testing

Serum sample for detection of measles-specific IgM antibody.

Throat swab (or nasopharyngeal swab) for RNA detection by real-time polymerase chain reaction (RT-PCR).

Measles complications (per 1,000 cases), US 1985-1992

<table>
<thead>
<tr>
<th>Complication</th>
<th>Risk (per 1,000 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>100</td>
</tr>
<tr>
<td>Otitis media</td>
<td>100</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>150</td>
</tr>
<tr>
<td>Seizures</td>
<td>7</td>
</tr>
<tr>
<td>Encephalitis</td>
<td>1</td>
</tr>
<tr>
<td>Death</td>
<td>3</td>
</tr>
</tbody>
</table>

- May cause premature birth or low birth weight.
- Subacute sclerosing panencephalitis: rare, but fatal.
- Case-fatality in among malnourished children as high as 30%.

Differential Diagnosis

- Rubella
- Fifth disease
- Enterovirus
- Adenovirus
- Mononucleosis
- Scarlet fever
- Roseola
- Kawasaki’s disease
- Rocky Mountain spotted fever
- Drug reactions
- MMR vaccine during past 2 weeks.
- And others . . . . . .

Diagnostic glitches

- False positive IgM.
- False negative IgM
- Cross reactivity with CMV, Herpes.
- Rheumatoid factor.
- Inexperienced clinicians.
- Recent MMR vaccinations.

Evidence of Measles Immunity

Acceptable presumptive evidence of immunity against measles includes at least one of the following:

- Written documentation of adequate vaccination:
  - 1 or more doses of a measles-containing vaccine administered on or after the first birthday for preschool-age children and adults not at high risk,
  - 2 doses of measles-containing vaccine for school-age children and adults at high risk, including college students, healthcare personnel, and international travelers.
- Laboratory evidence of immunity (measles IgG in serum).
- Laboratory confirmation of measles.
- Birth before 1957.
- Healthcare providers should not accept oral reports of vaccination without written documentation as presumptive evidence of immunity.

- For additional details about evidence of immunity criteria, see Table 3 in “Prevention of Measles, Rubella, Congenital Rubella Syndrome, and Mumps, 2013: Summary Recommendations of the Advisory Committee on Immunization Practices (ACIP)” [www.cdc.gov/mmwr/preview/mmwrhtml/rr6204a1.htm].
Measles response measures -A
• Assure proper care of patient.
• Verify diagnosis.
• Active surveillance to find other cases in family, school and community.
• Prospective contact study to find individuals who the case may have exposed (4 days before to 4 days after rash onset).
• Retrospective contact study to determine source of infection (back to 21 days before rash onset).
• MMR vaccination for all unvaccinated individuals who were exposed (must be done within 72 hours of exposure).

Measles response measures -B
• Immunoglobulin prophylaxis to exposed and susceptible persons within 6 days of exposure.
• Mass vaccination effort in community for unvaccinated individuals born in 1957 or after.
• Raise awareness to find susceptible persons (unvaccinated persons too young, <1 yr, or unvaccinated by choice).
• Case exclusions from daycare or school until 4 days after onset of rash.
• Exclude unvaccinated susceptible persons from daycares, school, and healthcare setting until 21 days after last rash onset.

Measles Case Definition (2013)
http://www.cdc.gov/measles/script/casedef.aspx?CondYrID=908&DatePub=1/1/2013%2012:00:00%20AM

Clinical Description
• An acute illness characterized by:
  - Generalized, maculopapular rash lasting 3–5 days; and
  - Temperature ≥101°F or ≥38.3°C; and
  - Cough, coryza, or conjunctivitis.

Case Classification
• Probable
  - In the absence of a more likely diagnosis, an illness that meets the clinical description with:
    - No epidemiologic linkage to a laboratory-confirmed measles case; and
    - Noncontributory or no measles laboratory testing.

• Confirmed
  - An acute febrile rash illness
    - With:
      - Temperature ≥101°F or ≥38.3°C; and
      - Cough, coryza, or conjunctivitis; and
      - Generalized, maculopapular rash lasting ≥3 days; and
      - One or more of the following:
        - Isolation of measles virus from a clinical specimen;
        - Detection of measles virus using polymerase chain reaction;
        - Positive serologic test for measles immunoglobulin G antibody (IgG in serum or IgM in acute serum)
        - Isolation of measles virus from a clinical specimen using polymerase chain reaction;
        - Positive serologic test for measles immunoglobulin M antibody (IgM in acute serum) using any evaluated method;
        - Direct epidemiologic linkage to a case confirmed by one of the methods above.

Measles deaths, United States, 1950-2015

Measles cases reported, USA, 1975-2016

Measles Strikes Again
Reported Cases in South Dakota, 2012-2016
Recent measles outbreaks in South Dakota

- **1990 measles outbreak**: University of South Dakota, 23 cases.
- **1997 measles outbreak in Central South Dakota**
  - 8 cases.
  - 3 generations of transmission.
  - Counties: Hughes (3) and Hyde (5).
  - Age median 23 yrs (range 12 mo – 37 yr).
  - Outbreak burnt out before DOH notified.
  - 7,678 people immunized in Pierre, Ft Pierre, and Highmore.

Dodging the viral bullet in South Dakota

- **2007**: Group of South Dakota students exposed to measles while attending science fair in Albuquerque. No cases.
- **2010**: Group of Sioux Falls school children exposed to measles while on Omaha field trip. No cases.
- **2011**: Measles outbreak in Minneapolis immigrant community exposed several South Dakota children. No cases.
- **2011**: North Dakota resident became sick with measles while staying in Rapid City motel and received care in local clinic. No secondary cases.
- **2016**: Refugee to Sioux Falls from Arizona Detention Center with measles outbreak.

We have been lucky, but it’s not all luck. It is good primary prevention by maintaining high vaccination coverage.

2014 – 2015 South Dakota Measles Outbreak

- **14 cases**
- ([each box = 1 case](#))

Measles outbreak: chain of events

- **November 2014**: Exposure Event: Unvaccinated adult Kansas resident takes trip to India.
- **30 Nov**: Case 1: Rash onset, hospitalized in Kansas, misdiagnosed. Visited by South Dakota family.
- **14 December**: Case 2: Rash onset, unvaccinated adult male, SD resident.
- **15 Dec**: Case 3: Rash onset, unvaccinated teen male, SD resident.
- **22 Dec**: Case 4: Rash onset, unvaccinated teen female, SD resident.
- **25 Dec**: Case 5: Rash onset, unvaccinated adult female, SD resident.
- **26 Dec**: Case 6: Rash onset, unvaccinated boy child, SD resident.
- **26 Dec**: Case 7: Rash onset, unvaccinated girl child, SD resident.
- **27 Dec**: Case 8: Rash onset, unvaccinated baby, SD resident.
- **REPORTED to DEPT of HEALTH.**

Measles outbreak: chain of events

- **29 Dec**: Case 9: Rash onset, unvaccinated adult female, SD resident.
- **3 January 2015**: Case 10: Rash onset, unvaccinated boy child, Arizona resident visiting SD family.
- **4 Jan**: Case 11: Rash onset, unvaccinated girl child, Arizona resident visiting SD family.
Measles outbreak: chain of events

- **5 Jan**: Case 12: Rash onset, unvacc pregnant Arizona resident visiting SD family.
- **10 Jan**: Case 13: Rash onset, unvaccinated adult male, SD resident.
- **14 Jan**: Case 14: Rash onset, unvacc girl child in Sioux Falls not connected with outbreak family.

Davison County, South Dakota Measles Outbreak:
13 cases and 187 contacts (as of 13 Jan 2015)

- 14 cases in 3 states.
- At least 187 contacts in 7 states.
- 4 generations of transmission.
- None immunized by personal choice.
- No deaths, one hospitalization.
- Age range 19 mo – 41 yr.
- DOH notified 27 December 2014 by Queen of Peace hospital.
- Active surveillance until 21 days after last case.
- Not related to concurrent Disneyland outbreak.

Disney Measles Outbreak, Dec 2014–Feb 2015

125 Measles cases:
California 110, Arizona 7, Colorado 1, Nebraska 1, Oregon 1, Utah 3, Canada 10, Mexico 1.

MMR vaccination (Measles, Mumps and Rubella) Recommendations

- **CHILDREN**: 2 doses of MMR vaccine:
  - 1<sup>st</sup> Dose: 12-15 months of age.
  - 2<sup>nd</sup> Dose: 4-6 years of age (may be given earlier, if at least 28 days after the 1<sup>st</sup> dose).
- Some infants younger than 12 months should get a dose of MMR if they are traveling out of the country. (This dose will not count toward their routine series.)
- MMR vaccine may be given at the same time as other vaccines.

MMR vaccination (Measles, Mumps and Rubella) Recommendations

- **ADULTS** should also get MMR vaccine:
  Generally, anyone 18 years of age or older who was born after 1956 should get at least 1 dose of MMR vaccine, unless they can show that they have either been vaccinated or had all 3 diseases.

MMR vaccination (Measles, Mumps and Rubella) Recommendations

- **HEALTHCARE workers**: If you were born in 1957 or later and have not had the MMR vaccine, or if you don’t have an up-to-date blood test that shows you are immune to measles or mumps (i.e., no serologic evidence of immunity or prior vaccination), get 2 doses of MMR (1 dose now and the 2nd dose at least 28 days later).
- If you were born in 1957 or later and have not had the MMR vaccine, or if you don’t have an up-to-date blood test that shows you are immune to rubella, only 1 dose of MMR is recommended.
- For HCWs born before 1957, see the MMR ACIP vaccine recommendations www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/mmr.html.

<table>
<thead>
<tr>
<th>Disease</th>
<th>South Dakota</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polio ≥4 doses</td>
<td>92.3%</td>
<td>91.5%</td>
</tr>
<tr>
<td>MMR ≥2 doses</td>
<td>97.7%</td>
<td>96.9%</td>
</tr>
<tr>
<td>Varicella ≥2 doses</td>
<td>91.7%</td>
<td>90.3%</td>
</tr>
<tr>
<td>Medical exemptions</td>
<td>1.3%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Non-Medical exemptions</td>
<td>1.1%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Varicella ≥2 doses</td>
<td>96.8%</td>
<td>95.0%</td>
</tr>
<tr>
<td>Tdap ≥1 doses since age 10</td>
<td>82.6%</td>
<td>82.9%</td>
</tr>
</tbody>
</table>

Vaccination coverage and exemptions for Kindergarten students, South Dakota and United States, 2014-15 school year

<table>
<thead>
<tr>
<th>Disease</th>
<th>South Dakota</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTaP ≥4 doses</td>
<td>97.2%</td>
<td>94.8%</td>
</tr>
<tr>
<td>MMR ≥2 doses</td>
<td>97.1%</td>
<td>95.0%</td>
</tr>
<tr>
<td>Varicella ≥2 doses</td>
<td>90.8%</td>
<td>90.3%</td>
</tr>
<tr>
<td>Medical exemptions</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Non-Medical exemptions</td>
<td>0.9%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

South Dakota school immunization statute

SDCL 13-28-7.3. Tests and immunizations for communicable diseases required for admission to school or any school program—Exceptions—Rules. Any pupil entering school or an early childhood program shall be tested for communicable diseases, including poliomyelitis, diptheria, tetanus, pertussis, rubella, rubella, mumps, tetanus, and varicella, according to recommendations provided by the Department of Health. The Department of Health may modify or delete any of the required immunizations. As an alternative to the requirement for a physician's certification, the pupil may present:

1. Certification from a licensed physician stating the physical condition of the child would be such that immunization would endanger the child's life or health; or
2. A written statement signed by one parent or guardian that the child is an adherent to a religious doctrine whose teachings are opposed to such immunization; or
3. A written statement signed by one parent or guardian requesting that the local health department give the immunization because the parents or guardians lack the means to pay for such immunization.

The Department of Health may promulgate reasonable rules, in accordance with chapter 1-26, to require compliance and documentation of adequate immunization, to define appropriate certification, and to specify standard procedure.

Source: SDCL 13-28-7.3; 33CDC. MMWR 31 July 2015; Vaccination coverage among adolescents aged 13 through 17 years—United States, 2014.

CDC. Vaccination Coverage Among Children at Kindergarten — United States, 2014–15 School Year. MMWR 28 Aug 2015. 64(33);897‐904.

Vaccination MMR coverage (%) at kindergarten entry by state, 2014-2015

Source: SDCL 13-28-7.3; 33CDC. MMWR 31 July 2015; Vaccination coverage among adolescents aged 13 through 17 years—United States, 2014.
American Academy of Pediatrics Reiterates Safety and Importance of Vaccines, 17 Sept 2015

• Claims that vaccines are linked to autism, or are unsafe when administered according to the recommended schedule, have been disproven by a robust body of medical literature. It is dangerous to public health to suggest otherwise.

• “There is no ‘alternative’ immunization schedule. Delaying vaccines only leaves a child at risk of disease for a longer period of time; it does not make vaccinating safer.

• “Vaccines work, plain and simple. Vaccines are one of the safest, most effective and most important medical innovations of our time. Pediatricians partner with parents to provide what is best for their child, and what is best is for children to be fully vaccinated.”

Salmonella Javiana Outbreak at a South Dakota Powwow 2016

Salmonellosis

• Bacteria: Gram negative enteric bacilli.

• Incubation period: Usually 12-36 hours (range 6-72 hours)

• Symptoms: Gastroenteritis. Sudden onset of diarrhea (may be bloody), abdominal cramps, fever, nausea, vomiting. May be invasive.

• Duration of illness: Usually 4 to 7 days.

• Treatment: Most individuals recover without treatment.

• Reservoir: Wild and domestic animals.

• Taxonomy: Approximately 2,500 serotypes. Most common in South Dakota: Typhimurium, Enteritidis, Newport.
Salmonellosis Incidence (cases per 100,000 population) South Dakota and United States, 2002 – 2015

South Dakota foodborne illness culture-confirmed incidence compared to FoodNet States, 2015

Salmonellosis case classifications

• **Suspect case:** Self diagnosed or physician guess.

• **Probable case:** Culture Independent Diagnosed or “Epi-Linked”.

• **Confirmed case:** Isolation of Salmonella spp. from a clinical specimen.

Epidemiologically linked case

A patient who had contact with someone who has the disease or was exposed to a source of infection.

1. Example: Sick sibling of a laboratory confirmed case.

2. Example: Sick person who ate the same food at a picnic as laboratory confirmed cases.

Culture Independent Diagnostic Tests

1. Commercial antigen-based tests (FDA-approved).

2. Commercial DNA-based syndrome panels (FDA-approved).

3. Laboratory-developed tests.

FilmArray GI Panel

1. Campylobacter
2. Clostridium difficile
3. Mesosinonas shigelloides
4. Salmonella
5. Yersinia enterocolitica
6. Vibrio
7. Vibrio cholerae
8. Diarrhetic E. coli
9. Shiga-like toxin-producing E. coli
10. E. coli O157

FilmArray GI Panel

11. Shigella/Enteroinvasive E. coli (EIEC)
12. Cryptosporidium
13. Cyclospora cayetanensis
14. Entamoeba histolytica
15. Giardia lamblia
16. Adenovirus F40/F41
17. Sapovirus (I, II, IV & V)
18. Astrovirus
19. Norovirus GI/GII
20. Rotavirus A

Why Dept of Health needs Salmonella isolates?

• Serotyping.

• Molecular typing for case linkage:
  • Pulse Field Gel Electrophoresis (PFGE).
  • Whole Genome Sequencing (WGS).

• National databases and linkages.
Recommendations for clinical laboratories using CIDT

- Reflexive culturing of CIDT specimens.
- Submit isolates of foodborne pathogens to South Dakota Public Health Laboratory (SDPHL).
- If isolates are not available, submit clinical material (stool, broths) to SDPHL.
- Review South Dakota’s disease reporting and mandatory isolate submission requirements [see handout].
- Use courier service to send isolates or clinical material to SDPHL in Pierre.
- Maintain effective and open communication with the SDPHL (Phone: 800-592-1861).
- Notify the SDPHL of your intent to implement CIDT.

Salmonella Outbreak

July 1, 2016
- 5 *Salmonella* cases reported from multiple labs.
- Investigation identified common exposure: powwow.
- Outbreak investigation initiated:
  - Start of July 4th weekend.
  - Health Alert sent to area healthcare providers.
  - Yankton Sioux Tribe and Wagner IHS contacted.
  - >1,100 people attended Powwow on 24-26 June 2016.
  - 2 catered meals at powwow.
  - Food history questionnaire created with menu items.

Salmonella Outbreak

5 July 2016
- 30 cases (confirmed, probable, and suspect).
- Outbreak serotype identified by SDPHL – *Salmonella* Javiana
  - Rare in SD (only 14 cases reported in past 6 years).
6 July 2016
- Media Blitz: local TV, radio, newspaper, and Facebook

Wateca: Food served

- Pork sandwich,
- Turkey sandwich,
- Beef sandwich,
- Chili dogs,
- Indian tacos,
- Hamburgers,
- Hotdogs,
- Chili,
- Chili fries,
- Dinner roll,
- Fruit salad,
- Cheesy hash browns,
- Baked beans,
- Macaroni salad,
- Potato salad,
- Cake,
- Kool-Aid.

Methods

Outbreak Case Definitions:

- **Confirmed**: An individual from whom *Salmonella* Javiana with the outbreak pattern (JGGX01.0172) was isolated.
- **Probable**: An individual who became ill with diarrhea after eating food served at the powwow, OR contact with a Confirmed case (epi-linked).

Results

112 cases (46 confirmed, 66 probable)

- Diarrhea 100%
  - Bloody diarrhea 19%
- Vomiting 51%
- Fever 71%
- Hospitalized: 28% (N=30)
- Duration of illness: 6 days median (range 1-20)
- Race: 96% American Indian, 3% White, 1% Other
Environmental Investigation

- Inspected local caterer, casino and powwow food serving station.
  - Food served from 4:30 – 6:10PM at powwow.
  - "Wateca" All leftover food left out (not refrigerated) and given to whomever wanted to take it home.
  - The only refrigerator available was full and ice used for salads had melted.
  - Some food sat out until midnight (>6 hours out of temperature control).
  - Trace back of implicated foods.
  - The caterer denied any food workers being ill.

Conclusions

- Outbreak of *Salmonella* Javiana associated with food served at the powwow.
- Ultimate source not determined, but most likely originated with an ill or asymptomatic infected food worker who had extensive bare-hand contact with food items.
- Deficiencies in temperature controls and potential for cross-contamination may have contributed to survival and proliferation of *Salmonella*.

Influenza in South Dakota
Influenza surveillance

- Track influenza-like illness (ILI).
- Determine what influenza viruses are circulating.
- Measure the influenza's impact: hospitalizations and deaths.
- Influenza surveillance conducted year round.
- Enhanced surveillance October – May.
  1. Laboratory confirmed influenza cases (PCR, culture, DFA).
  2. Aggregate Influenza Rapid Antigen reporting.
  3. ILI Net: 34 sentinel physicians.
  4. Influenza-associated deaths.
  5. Influenza-associated hospitalizations.
  7. School Illness Absentee Reporting.
  8. Outbreaks (schools, day-care, long term care facilities).

Confirmed influenza cases, South Dakota 5 seasons 2012-2017

<table>
<thead>
<tr>
<th>Season</th>
<th>Confirmed Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-13</td>
<td>135</td>
</tr>
<tr>
<td>2013-14</td>
<td>134</td>
</tr>
<tr>
<td>2014-15</td>
<td>257</td>
</tr>
<tr>
<td>2015-16</td>
<td>279</td>
</tr>
<tr>
<td>2016-17</td>
<td>225</td>
</tr>
</tbody>
</table>

Influenza hospitalizations, South Dakota 2007-2016

<table>
<thead>
<tr>
<th>Season</th>
<th>H3N2</th>
<th>H1N1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-08</td>
<td>361</td>
<td>134</td>
</tr>
<tr>
<td>2008-09</td>
<td>114</td>
<td>292</td>
</tr>
<tr>
<td>2009-10</td>
<td>164</td>
<td>165</td>
</tr>
<tr>
<td>2010-11</td>
<td>239</td>
<td>161</td>
</tr>
<tr>
<td>2011-12</td>
<td>783</td>
<td></td>
</tr>
</tbody>
</table>

Influenza deaths, South Dakota 2003-2016

<table>
<thead>
<tr>
<th>Season</th>
<th>H3N2</th>
<th>H1N1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-04</td>
<td>42</td>
<td>25</td>
</tr>
<tr>
<td>2004-05</td>
<td>38</td>
<td>42</td>
</tr>
<tr>
<td>2005-06</td>
<td>40</td>
<td>22</td>
</tr>
<tr>
<td>2006-07</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>2007-08</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td>2008-09</td>
<td>12</td>
<td>38</td>
</tr>
<tr>
<td>2009-10</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

Vaccine effectiveness (±95%CI) estimates for influenza seasons, 2004-2017

<table>
<thead>
<tr>
<th>Season</th>
<th>H3N2</th>
<th>H1N1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>48</td>
<td>75</td>
</tr>
<tr>
<td>2005-06</td>
<td>70</td>
<td>56</td>
</tr>
<tr>
<td>2006-07</td>
<td>59</td>
<td>56</td>
</tr>
<tr>
<td>2007-08</td>
<td>53</td>
<td>57</td>
</tr>
<tr>
<td>2008-09</td>
<td>52</td>
<td>56</td>
</tr>
<tr>
<td>2009-10</td>
<td>47</td>
<td>58</td>
</tr>
<tr>
<td>2010-11</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>2011-12</td>
<td>51</td>
<td>57</td>
</tr>
<tr>
<td>2012-13</td>
<td>47</td>
<td>49</td>
</tr>
<tr>
<td>2013-14</td>
<td>49</td>
<td>51</td>
</tr>
<tr>
<td>2014-15</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>2015-16</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td>2016-17</td>
<td>47</td>
<td>48</td>
</tr>
</tbody>
</table>