Why do vaccine-preventable disease outbreaks (still) occur in the US?

Two Main Epidemiological Concepts

- **Reproduction number** - $R_0$ ("R naught")
- **Community immunity**
  - "herd" immunity
  - population immunity

**Reproduction number**

- The (average) number of secondary cases resulting from an infected person in a completely susceptible population.

- Influenced by
  - Transmissibility of the pathogen
  - Probability of infection resulting from a contact
  - Duration of infectious period

- Other factors in disease spread
  - Proportion of susceptibles
  - Duration of immunity
  - Population dynamics
  - Pattern(s) of mixing of individuals

**Values of $R_0$ of well-known infectious diseases**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Transmission</th>
<th>$R_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>Airborne</td>
<td>12–18</td>
</tr>
<tr>
<td>Pertussis</td>
<td>Airborne droplet</td>
<td>12–17</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>Saliva</td>
<td>6–7</td>
</tr>
<tr>
<td>Smallpox</td>
<td>Social contact</td>
<td>5–7</td>
</tr>
<tr>
<td>Polio</td>
<td>Fecal-oral route</td>
<td>5–7</td>
</tr>
<tr>
<td>Rubella</td>
<td>Airborne droplet</td>
<td>5–7</td>
</tr>
<tr>
<td>Mumps</td>
<td>Airborne droplet</td>
<td>4–7</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>Sexual contact</td>
<td>2–5</td>
</tr>
<tr>
<td>SARS</td>
<td>Airborne droplet</td>
<td>2–5</td>
</tr>
<tr>
<td>Influenza</td>
<td>Airborne droplet</td>
<td>2–3</td>
</tr>
</tbody>
</table>

(H1N1 pandemic strain)

**Herd immunity**

- Protection provided to non-immune individuals when a significant % of the population have immunity

- "Herd" immunity implies
  - Disease risk reduced for susceptible persons by the presence & proximity of immune individuals ("indirect protection")

  - Achieving threshold proportion of immunity should lead to decline in disease
These slides were presented at the MDCH Fall Regional Immunization Conference on Nov. 22, 2013, in Troy, Michigan. This information is valid as of 11/22/13.
Kindergarten immunization coverage

For the 2012–13 school year, national median vaccination coverage for kindergarteners:

- 94.5% for MMR vx
- 95.1% for DTaP vx
- 93.8% for Varicella vx

Source: MMWR, August 2, 2013 / 62(30):607-612

Waivers

**FIGURE** Estimated percentage of children enrolled in kindergarten who have been vaccinated for one or more vaccine-preventable diseases, 2012–13 school year.

*Categories might not reflect all children enrolled in kindergarten who have been vaccinated for one or more vaccine-preventable diseases. Those who have an exemption but are not in the clinic are not in the vaccinated category.

Source: MMWR, August 2, 2013 / 62(30):607-612

Measles outbreak, Netherlands, 2013 (May-present)

Most cases occurred in municipalities with MMR vaccination coverage below 90%

Reported measles cases by municipality, 1 May-23 August 2013 (panel a), and vaccination coverage of live MMR vaccine by municipality for both doses 2009-2013 (panel b), the Netherlands


Coverage of 2 or More Doses of MMR²
Adolescents Aged 13-17 Years Old, 2011
National =91% 20 states < 90%

Source: National Immunization Survey – Teen 2011, CDC

USA TODAY

Vaccine refusal linked to California pertussis outbreak

Michelle Holmgren, USA TODAY 6:55 a.m. EDT September 4, 2012

New evidence suggests that clusters of people who refused the whooping cough vaccine may have been one of the factors that contributed to California’s 2010 whooping cough outbreak.


Reported measles, Europe 2012

Figure 4. Number of measles cases by country, January – December 2012, EU/EEA countries (n=9 256), and two dose measles vaccine coverage (2011-12 EU) EU/EEA countries

Source: European Centre for Disease Prevention and Control/TESSy

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