Vaccination-Strategies

- Active immunity produced by vaccine
- Immunity and immunologic memory similar to natural infection but without risk of disease.

General Rule:

The more similar a vaccine is to the disease-causing form of the organism, the better the immune response to the vaccine.

Classification of Vaccines

- Live attenuated
  - viral
  - bacterial
- Inactivated
### Inactivated Vaccines

<table>
<thead>
<tr>
<th>Whole</th>
<th>Fractional</th>
</tr>
</thead>
<tbody>
<tr>
<td>• viruses</td>
<td>• protein-based</td>
</tr>
<tr>
<td>• bacteria</td>
<td>– toxoid</td>
</tr>
<tr>
<td></td>
<td>– subunit</td>
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<tr>
<td></td>
<td>• polysaccharide-based</td>
</tr>
<tr>
<td></td>
<td>– pure</td>
</tr>
<tr>
<td></td>
<td>– conjugate</td>
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</tbody>
</table>

### Live Attenuated Vaccines

- Attenuated (weakened) form of the "wild" virus or bacterium
- Must replicate to be effective
- Immune response similar to natural infection
- Usually effective with one dose*  

*except those administered orally
Live Attenuated Vaccines

- Severe reactions possible
- Interference from circulating antibody
- Fragile – must be stored and handled carefully

Live Attenuated Vaccines

- Viral: measles, mumps, rubella, vaccinia, varicella/zoster, yellow fever, rotavirus, intranasal influenza, oral polio*
- Bacterial: BCG, oral typhoid

*not available in the United States
Inactivated Vaccines

- Cannot replicate
- Generally not as effective as live vaccines
- Less interference from circulating antibody than live vaccines
- Generally require 3-5 doses
- Immune response mostly humoral
- Antibody titer may diminish with time

Whole-cell vaccines

- Viral  
  polio, hepatitis A, 
  rabies, influenza*

- Bacterial  
  pertussis*, typhoid* 
  cholera*, plague*

*not available in the United States
Inactivated Vaccines

Fractional vaccines
• Subunit hepatitis B, influenza, acellular pertussis, human papillomavirus, anthrax, Lyme*

• Toxoid diphtheria, tetanus

*not available in the United States

Pure Polysaccharide Vaccines

• Not consistently immunogenic in children younger than 2 years of age
• No booster response
• Antibody with less functional activity
• Immunogenicity improved by conjugation
## Polysaccharide Vaccines

### Pure polysaccharide
- pneumococcal
- meningococcal
- *Salmonella* Typhi (Vi)

### Conjugate polysaccharide
- *Haemophilus influenzae* type b
- pneumococcal
- meningococcal

## Type of Vaccines by route of administration

<table>
<thead>
<tr>
<th>Type of Administration</th>
<th>Bacterial</th>
<th>Viral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intramuscular</td>
<td>Diphtheria</td>
<td>Hepatitis A</td>
</tr>
<tr>
<td></td>
<td>Tetanus</td>
<td>Hepatitis B</td>
</tr>
<tr>
<td></td>
<td>Pertussis (whole cell)</td>
<td><em>Haemophilus influenzae</em> b</td>
</tr>
<tr>
<td></td>
<td>Acellular Pertussis</td>
<td>Most Flu</td>
</tr>
<tr>
<td></td>
<td>Plague</td>
<td>Rabies</td>
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<tr>
<td></td>
<td>Pneumococcal</td>
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<td>Typhoid Vi</td>
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<tr>
<td>Subcutaneous</td>
<td>Anthrax</td>
<td>Japanese Encephalitis Virus</td>
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<td></td>
<td>Meningococcal</td>
<td>Measles</td>
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<tr>
<td></td>
<td>Pneumococcal</td>
<td>Mumps</td>
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<tr>
<td></td>
<td></td>
<td>Rubella</td>
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<tr>
<td></td>
<td></td>
<td>Polio (IPV)</td>
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<tr>
<td></td>
<td></td>
<td>Varicella</td>
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<td></td>
<td></td>
<td>Yellow Fever</td>
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<tr>
<td>Intradermal</td>
<td>BCG</td>
<td>Vaccinia (Smallpox)</td>
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<tr>
<td></td>
<td></td>
<td>Rabies (HDCV for pre-exposure vaccine)</td>
</tr>
<tr>
<td>Inhaled</td>
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<td>FluMist</td>
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<tr>
<td>Oral</td>
<td>Rotavirus</td>
<td>Polio (OPV)</td>
</tr>
<tr>
<td></td>
<td>Ty21a</td>
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</tr>
</tbody>
</table>
Principles of Vaccination

General Rule

Inactivated vaccines are generally not affected by circulating antibody to the antigen.

Live attenuated vaccines may be affected by circulating antibody to the antigen.

Intervals and Ages

• Vaccine doses should not be administered at intervals less than the minimum intervals or earlier than the minimum age
  
  Vaccination doesn't count

• It is not necessary to restart the series or add doses because of an extended interval between doses
  
  Vaccination counts
Vaccine Adverse Reactions

- **Local**
  - pain, swelling, redness at site of injection
  - common with inactivated vaccines
  - usually mild and self-limited

- **Systemic**
  - fever, malaise, headache
  - nonspecific
  - may be unrelated to vaccine

Contraindications and Precautions

**Contraindication:**
- A condition in a recipient that greatly increases the chance of a serious adverse reaction.

**Precaution:**
- A condition in a recipient that might increase the chance or severity of an adverse reaction, or
- Might compromise the ability of the vaccine to produce immunity
Contraindications and Precautions

Permanent contraindications to vaccination:

• severe allergic reaction to a vaccine component or following a prior dose

• encephalopathy not due to another identifiable cause occurring within 7 days of pertussis vaccination

Vaccination of Pregnant Women

• Live vaccines should not be administered to women known to be pregnant

• In general inactivated vaccines may be administered to pregnant women for whom they are indicated
Vaccination of Immunosuppressed Persons

- Live vaccines should not be administered to severely immunosuppressed persons
- Inactivated vaccines are safe to use in immunosuppressed persons but the response to the vaccine may be decreased

Invalid Contraindications to Vaccination

- Mild illness
- Antimicrobial therapy
- Disease exposure or convalescence
- Pregnant or immunosuppressed person in the household
- Breastfeeding
- Preterm birth
- Allergy to products not present in vaccine or allergy that is not anaphylactic
- Family history of adverse events
- Tuberculin skin testing
- Multiple vaccines
Vaccination During Acute Illness

- No evidence that acute illness reduces vaccine efficacy or increases vaccine adverse reactions
- Vaccines should be delayed until the illness has improved
- Mild illness, such as otitis media or an upper respiratory infection, is NOT a contraindication to vaccination

What is in a vaccine?

Vaccines have:
- Antigenic material (live attenuated, killed etc.)
- Stabilizers (mono sodium glutamate, 2-phenoxy ethanol)
- Adjuvants (increase immune response)
- Preservatives (prevent fungal and bacterial growth)
  (e.g. antibiotics, formaldehyde and thimerosal)
Thimerosal

Organic mercury has antifungal and antibacterial properties.
Used in multidose vials to prevent contamination
Not needed in more expensive single dose vaccines.
No convincing evidence that thiomersal is a factor in the onset of autism?
Currently not used for recommended childhood vaccines

Adjuvant

- Substances that enhance the immune response
- Two categories:
  - vehicles
  - immunomodulators
Adjuvants functioning as vehicles I

- Human use:
  - Alum compounds
    - Aluminum hydroxide and phosphate
    - the only licensed adjuvants in U.S.
  - MF59
    - Oil and water emulsion
    - Marketed in Europe

Adjuvants functioning as vehicles cont.

- Animal use:
  - Freund’s Complete Adjuvant (CFA)
    - desiccated *Mycobacterium butyricum*, mineral oil and an emulsifying agent, mannide monooleate
    - causes potentially severe local inflammatory lesions, chronic granulomas, abscesses, and tissue sloughs. Injected into the murine footpad, it can cause chronic lameness and arthritis; injected intraperitoneally, it can cause peritonitis
  - Freund’s Incomplete Adjuvant
    - Mineral oil and Mannide monooleate
    - Fewer side effects, adequate for boosting
Immunomodulatory Adjuvants

- Purified Protein Derivative (PPD)
- Lipopolysaccharide (LPS; bacterial endotoxin)
- Lipid A - lipid portion of LPS
- Cholera toxin B subunit
- CpG

Immunization schedule for children