How Vaccines Work

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Vaccine Geek

- SHOTS app content expert
- National Vaccine Advisory Committee
- Liaison Mumps Work Group of the Advisory Committee on Immunization Practices (ACIP,CDC)
- Co Chair New Mexico Immunization Practice Advisory Committee
- UNMH Adult Immunization Task Force
- Medical Director UNMH COVID Vaccine Clinic

Objectives

- Organize vaccines by how they are made (type of vaccine)
- Use vaccine type to predict vaccine properties
- Define "shared decision making" recommendations
- Describe vaccine adjuvants

Conflicts

- Nothing to declare

Types of Vaccines

- Live Attenuated
- Inactivated
- Whole
- Conjugated
- Subunit
- mRNA
- Recombinant DNA
- Toxoid

Killed Virus
Immunity Simplified

Antigen Presenting Cell

T Helper Cells

Killer T Cells

Active Killer T Cells

Plasma Cells

B Cells

Antibodies surround Pathogen

Killer T Cells

Active Killer T Cells

Immunity Simplified

Plotkin et al. Vaccine (textbook)

Second infection or infection after immunization

Plotkin et al. Vaccine (textbook)

MMR: Live Attenuated Vaccine

Live Attenuated

Inactivated

Whole

Conjugated

Unconjugated

Fractionated

Protein

Polysaccharide

DNA

Toxoid

Adjuvanted

1st Measles

MMR: Live Attenuated Vaccine

• Recognized by the human immune system
• Replicates in human host

Reported Measles Cases in the United States by Year 1940 - 2000

1st Measles

MMR

Live Attenuated

Inactivated

Whole

Conjugated

Unconjugated

Fractionated

Protein

Polysaccharide

DNA

Toxoid

Adjuvanted
Influenza Live Attenuated Influenza Vaccine

- Intranasal IgA as well as IgG
- 2016-2018 not recommended
- 2018-19 reformulated—may use waiting for data

https://www.cdc.gov/flu/prevent/nasalspray.htm

Varicella

Chicken Pox
- Vesicular rash
- Fever
- Highly contagious

Shingles
- Rash in dermatome distribution
- Very painful
- Post Herpetic Neuralgia
- Can cause blindness
- Not as communicable as Chicken Pox
- Susceptible people contact fluid from vesicles

Varicella Vaccine

Children under age 13 years
- First dose at age 12 through 15 months
- Second dose at age 4 through 6 years

Catch Up
- Age 13 and up never had vaccine or chicken pox
- 2 doses 28 days apart

First shingles Vaccine

HZV (Zostavax)
- 4X dose of varicella antigen
- Herpes Zoster Efficacy 51.3%
- 4 years duration
- Post Herpetic Neuralgia Efficacy 66.5%

Key Points Live Attenuated Vaccines

- Immune response like natural infection
- Antigen Presenting Cells
- Fragile-temperature sensitive
- Concern convert to virulent
- Caution Pregnancy and Immunocompromised

Varicella human embryonic lung cell culture embryonic guinea pig fibroblasts Other Cells types 31 passages

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Hepatitis A

- All children aged 12–23 months
- Unvaccinated children and adolescents aged 2–18 years
- International travelers
- Men who have sex with men
- People who use injection or non-injection drugs
- People who have occupational risk for infection
- People who anticipate close contact with an international adoptee
- People experiencing homelessness
- People with HIV
- People with chronic liver disease
- Any person wishing to obtain immunity (protection)
- In addition, a person who has not previously received hepatitis A vaccine and who has direct contact with someone with hepatitis A should get hepatitis A vaccine within 2 weeks after exposure

Key Points Whole Cell Vaccines

- Often need more than one dose
- Immunity wanes
- Example Hepatitis A
Pneumococcal Vaccines

**Pneumovax® PPSV23**
- Polysaccharide
- 1980s
- 23 Valant

**Prevnar® PCV13**
- Conjugated protein to Polysaccharide
- PCV7 - 1998
- PCV13 2009
- 13 types

Children

**Routine:** PCV13
- 2 month
- 4 months
- 6 months
- 12-18 months
- 4-6 years

**Underlying conditions**
- PCV13
- Later PPSV23 at least 8 weeks after PCV13

Pneumococcal

**Age 19-64 Years With Underlying Condition(s)**

A. Smoker, Long-term facility resident, or Chronic conditions: Heart disease (including hypertension) Diabetes

B. Immune-compromised: Including HIV, Chronic renal failure, Neutropenic syndome, or Asplenia

C. CSF leaks or Cochlear implants

**Pneumococcal Vaccine Timing For Adults**

**Age 65 Years or Older**

- 1st dose
- 8 weeks
- 5 years
- 2nd dose

**Age 19-64 Years**

- 1st dose
- 8 weeks
- 2nd dose

- 2nd dose
- 8 weeks
- 3rd dose

- 2nd dose
- 8 weeks
- 4th dose
Pneumococcal incidence for those 65 years and up 1997-2013 in the US

Incidence of pneumococcal disease in 65+ went down PCV 13 given to children

Data from: ABCS /CDC

Invasive pneumococcal disease (IPD) incidence among adults aged ≥65 years, by pneumococcal serotype* — United States, 1998–2017

Adults ≥65 likely to benefit

Have conditions that make IPD more likely
- chronic heart, lung, or liver disease
- diabetes, or alcoholism
- cigarette smokers
- more than one chronic medical condition

Meningococcal Polysaccharide Vaccine

Bacteria with capsules

Short duration
Meningococcal conjugated ACYW

Age 11-18 + booster age 16
Strains: ACYW

Summary Polysaccharide Vaccines

- Bacteria with capsules
- Conjugated more immunogenic
- Infection with these bacteria higher in
  - Immunocompromised
  - No spleen
  - Extremes of age

Tetanus and Diphtheria

**Tetanus**
- *Clostridium tetani*
- Spores in soil in some parts of the world
- Antigen=inactive toxin=toxoid
- Tetanus=spasm due to neurotoxin

**Diphtheria**
- *Corynebacterium diphtheriae*
- Lives in bodies-only toxic with corynebacteriophages
- Antigen=inactive toxin
- Pseudomembrane and respiratory compromise

Plotkin et al. Vaccine (textbook)
People of all ages need WHOOPING COUGH VACCINES

DTap
Tdap
Tdap
Tdap
Tdap
Tdap

Influenza: Split Virus Vaccine

Influenza: Subunit Virus (Recombinant) Vaccine
Influenza for Seniors

Standard Dose
- Not as effective over 65
- Still good
- High dose
- Slightly more effective
- Adjuvanted

Adjuvants

- Oil-in-water emulsions (MF59, AS03)
- Virosomes
- AS04
- AS01
- MPRC
- S29
- Liposomes (AS01)
- CpG ODN (1018 ISS)
- TLR7 ligand

ADJUVANT

Substances included in a vaccine formulation to enhance the quality and strength of the immune response induced by the vaccine antigen(s)

- less immunogenic antigens
- lower antigen doses needed
- enhancing immune response in elderly
- young children
- chronic diseases
- immunocompromised


Advisory Committee on Immunization Practices (ACIP)

- Routine HPV vaccination at age 11 or 12 years
- Can be started beginning at age 9 years
- Also recommended aged 13-26 years who have not been vaccinated previously

Age 26 and up: Shared Decision Making

Meningococcal B vaccine=subunit vaccine

Meningococcal B Bacteria

Burden of Disease

CDC Estimated Annual Meningococcal B Cases in 11-24 year olds

<table>
<thead>
<tr>
<th>Cases</th>
<th>Deaths</th>
<th>Sequelae</th>
</tr>
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<tbody>
<tr>
<td>54-67</td>
<td>5-10</td>
<td>5-13</td>
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MacNeil ACIP June 2015
A serogroup B meningococcal vaccine series may be administered to adolescents and young adults 16-23 years of age to provide short-term protection against most strains of group B meningococcal disease.
Herpes Zoster subunit vaccine

- Recommended for the prevention of herpes zoster and complications in immune-competent adults aged 50 up
- Preferred over Zoster Vaccine Live (Zostavax)
- Recommended for immune-competent even if they have received Zostavax

ACIP October 2017

HZV subunit

- More reactions:
  - Vaccine 79.0%
  - Placebo 29.5%
- Administration
  - 2 doses: Zero and 2-6 months
  - 2 vials: adjuvant and vaccine are combined in syringe
  - Price $130-170 per dose

Key Points: Split and Subunit Vaccines

- Antigens
  - Removed from virus/bacteria (split)
  - Recombinant (subunit)
  - Probably safe in immunocompromised

- Adjuvant improves efficacy but causes more reactions
  - Caution in pregnancy
  - More reactive

mRNA Vaccines

- Pfizer/BioNTech: BNT162b2
  - Preliminary Efficacy 95%
  - Doses: 2, 21 days apart
  - Cold Chain: -70°C
  - 79 Countries (at this time)

- Moderna: mRNA-1273
  - Preliminary Efficacy 94%
  - Doses: 2, 28 days apart
  - Cold Chain: -20°C
  - 41 Countries (at this time)
Diphtheria
Tetanus
Pertussis
Influenza
HPV
Men B
Hep B
New Hep B
New Shingles
Influenza
Adjuvanted Influenza
High dose Influenza

Vector-Based Vaccines (DNA)

Human Cell

Vector-Based Vaccines (DNA)

Vector-Based Vaccines (DNA)

Thank you!

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