

Immunization

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Introduction

Immunization is the process of introducing an antigen into the body to induce protection against an infectious agent without causing disease.

Introduction

Vaccines are substances administered to generate a protective immune response.

Toxoids are inactivated bacterial toxins. They retain the ability to stimulate the formation of antitoxin, which are antibodies directed against the bacterial toxin.

Adjuvants are inert substances, such as aluminum salts (i.e., alum), which enhance vaccine antigenicity by prolonging antigen absorption.

Immune sera are sterile solutions containing antibody derived from human (immune globulin [IG]) or equine (antitoxin) sources.

Immunization

Immunization

Toxoids

Vaccines

Immune globulins

Live attenuated

inactivated

Bacterial

Virus

Bacterial

Virus

Vaccine Preparations

- Live attenuated
 - Weakened form of pathogen
 - Still replicates after administration
 - Fragile (Interference with improper storage et al)
 - Longer lasting immunity even with single dose
 - More adverse effects especially in immunocompromised persons

Vaccine Preparations Cont'd

- Inactivated
 - Whole organism or antigenic fraction
 - cannot replicate
 - Antigenic fractions:
 - Protein-based with subunits
 - Polysaccharide-based
 - Less antigenic than protein-based especially at < 2 years old
 - May be conjugated to protein to increase immune response
- Generally not as effective as live vaccines
 - May require 3-5 doses
 - Antibody titer may diminish with time

Vaccine Preparations 3

Form	Examples
Live Attenuated	Measles, Mumps, Rubella Varicella, Zoster, Yellow Fever, Rotavirus Intranasal Influenza, Oral Typhoid, Vaccinia
Inactivated	
Whole organism	Hepatitis A, Polio, Rabies, Cholera et al
Fractional	
Pure polysaccharide	Pneumococcal (<i>Pneumovax</i>) Meningococcal (<i>Menomune</i>)
Conjugate polysaccharide	Pneumococcal (<i>Prevnar</i>) Meningococcal (<i>Menactra</i>) <i>Haemophilus influenzae</i> type b
Protein	Acellular Pertussis, Tetanus, Diphtheria Hepatitis B, Influenza, Human Papillomavirus

Comparison of Pre-Vaccine and Current Reported Morbidity of Vaccine-Preventable Diseases and Vaccine Adverse Events, United States

Disease	Pre-vaccine Era*	2006**	% decrease
Diphtheria	175,885	0	100
Measles	503,282	55	99.9
Mumps	152,209	6,584	95.7
Pertussis	147,271	15,632	89.4
Polio (paralytic)	16,316	0	100
Rubella	47,745	11	99.9
Congenital Rubella Syn.	823	1	99.9
Tetanus	1,314	41	96.9
<i>H. influenzae</i> type b and unknown (<5 yrs)	20,000+	208	99.0
Total	1,064,854	22,532	97.9
Vaccine Adverse Events	N/A	15,484	+++

* Baseline 20th century annual morbidity

+ Estimated because no national reporting existed in the pre-vaccine era

** Source: *MMWR* 2007;56(33):851-64

General rules for giving vaccines

- All vaccines can be administered at the same visit as all other vaccines
 - Exception: don't give two live vaccines at same time, separate by at least 4 weeks
- Separate administration of vaccines from antibodies
 - e.g. wait 3 months after antibody to give vaccine
- Vaccination is less effective if given too soon
 - Before indicated age
 - Giving 2nd dose of a multi dose series before due
 - Will still be effective if given later than it is due

Vaccines in Pregnancy

- Live virus vaccines are generally contraindicated in pregnant women.

According to the Centers for Disease Control and Prevention (CDC).

- No evidence shows an increased risk from vaccinating pregnant women with inactivated virus or bacterial vaccines or toxoids.
- Hepatitis A, hepatitis B, meningococcal, inactivated polio, and pneumococcal polysaccharide vaccines should be administered to pregnant women who are at risk for contracting these infections.

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

Vaccine Adverse Reactions 2

- Allergic
 - due to vaccine or vaccine component
 - rare, risk minimized by screening
 - A condition in a recipient that greatly increases the chance of a serious adverse reaction
- Vaccine Adverse Event Reporting System (VAERS)
www.vaers.hhs.gov

Thimersol

- Mercury based preservative used for decades
- Concerns raised about autism risk
 - Researched by federal agencies (FDA, CDC & NIH) & leading independent scientific groups (IOM, ACIP, AAP)
 - Found no association/increased risk
 - To avoid controversy, removed from single dose vials, still in multi-dose.
 - No reduction in autism (probably multi-factorial)

Guillain-Barre Syndrome (GBS)

- Rare (1-2 cases per 100,000 persons) neurologic auto-immune disorder
- Old influenza vaccines (1976) associated with one additional case per 100,000
- New influenza vaccines add only 1:1,000,000

Contraindications

Contraindication	Live	Inactivated
Allergy to Component	Contraindicated	Contraindicated
Encephalopathy	n/a	Contraindicated
Pregnancy	Contraindicated	Vaccinate*
Immunosuppression †	Contraindicated	Vaccinate
Severe illness	Precaution	Precaution
Recent blood products	Precaution**	Vaccinate

* Except HPV or Tdap (give pre or post-partum), ** MMR or varicella

† due to transplantation and / or disease (malignancy, HIV) or chemotherapy (including corticosteroids at greater than 20 mg or 2 mg/kg/day). Consult experts if needed.

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

Screening Questions

- Has the child taken cortisone, prednisone, other steroids, or anticancer drugs, or had x-ray treatments in the past 3 months?
- Has the child received a transfusion of blood or blood products, or been given a medicine called immune (gamma) globulin in the past year?
- Is the child/teen pregnant or is there a chance she could become pregnant during the next month?
- Has the child received vaccinations in the past 4 weeks?

Tetanus, diphtheria (Td) +/- Acellular Pertussis (Tdap)

- Child primary vaccination = 4 doses of DTaP
- Adult primary vaccination

Child: 2,4,6 months then 15 to 18 months and 4 to 6 years of age

Adult booster Td* every 10 years

Measles, Mumps, Rubella (MMR)

- Live attenuated
 - Contraindicated in pregnancy, immunodeficiency
- Child primary vaccination = 2 separate doses @ ≥ 12 months
- Adults born after 1957 without reliable history of immunity
 - Single dose

Human Papillomavirus (*Gardasil*) [HPV]

- Sexually transmitted, very frequent in young women
- Vaccine prevents most common types of HPV that cause cervical cancer and genital warts
- Women ≤ 26 years old who have had or will ever have sex
- 3 separate doses at 0, 2 and 6 months

Varicella & Zoster

- Varicella (*Varivax*) [Chickenpox] live vaccine
 - Children over 12 months: 2 separate doses
 - High risk adults (healthcare workers without evidence of immunity): 2 doses separated by 4 weeks
- Zoster (*Zostavax*) [Shingles]
 - Immuno-competent persons > 60 years old: single dose

Hepatitis A, B

- Hepatitis A (*Havrix, Vaqta*)
 - Children: all at > 1 year as 2 separate doses
 - Adults: Medical, occupational or behavioral risk as 2 separate doses 6 months apart. No booster needed
- Hepatitis B (*Engerix-B, Recombivax-HB*)
 - Children: at birth (+/- HBIG per mom) then complete series
 - Adults: Medical, occupational or behavioral risk as 3-4 separate doses 6 months apart. No booster needed
- Combined A/B (*Twinrix*)

Pneumococcal

- Children:

- all at > 2 months as 4 separate dose series using pneumococcal conjugate vaccine (PVC7)
- at > 2 years give single pneumococcal polysaccharide vaccine (PPSV23) to high risk children

- Adults:

- > 65 years old or < 65 years old and asthma, smoker, chronic illness (diabetes, heart disease, pulmonary disease, liver disease, kidney disease, asplenic et al)
- single dose of PPSV23

Meningococcal

- Meningococcal conjugate vaccine (MCV)
- Meningococcal polysaccharide vaccine (MPSV)
 - (*Menactra* (adds diphtheria toxoid), *Menomune*)
- Children
 - Asplenic or similar risk: single dose; may need booster
- Adults
 - anatomic or functional asplenia, 1st year college students living in dormitories, lab personnel, military recruits, travelers (i.e. Hajj!)
 - Single dose, MCV preferred in adults < 55 years old

Other vaccines

- Inactivated poliovirus
 - 4 dose series for all children after 2 months
- Rotavirus
 - 3 dose series for all children
 - 1st dose at 6-14 weeks
- Risk factors including travel:
 - Rabies, Typhoid, Yellow Fever et al

Influenza Vaccines

- 70% effective in preventing infection
- > 60% reduction in influenza-associated morbidity
 - Lower in elderly or if poor antigenic match
- New formulation each year trying to match circulating strains (two A, one B)

Influenza Vaccines Cont'd

- Seasonal normally peaks in February
 - Vaccinate in October or November in US
 - ≥ 50 years old, chronic medical conditions, women in 3rd trimester during flu season, healthcare workers & close contacts of high risk persons +/- international travelers
- H1N1 peaking now, little immunity except elderly
 - Priority to vaccinate for pregnant women (not with live vax), those with children < 6 months old, those 6 months – 24 years old, those 25-65 with high-risk medical conditions
- Inactivated; Live Attenuated for both Seasonal & H1N1
 - CSL Biotherapies, GSK, Novartis, Sanofi Pasteur; MedImmune

Putting it all together


- Annually updated vaccination schedules from CDC (www.cdc.gov)
 - Age 0 – 6
 - Age 7-18
 - Adults

Recommended Immunization Schedule for Persons Aged 0 Through 6 Years—United States • 2009

For those who fall behind or start late, see the catch-up schedule

Vaccine ▼	Age ►	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	19–23 months	2–3 years	4–6 years
Hepatitis B ¹	BCG		HepB		<i>see footnote 1</i>		HepB					
Rotavirus ²				RV	RV	RV ²						
Diphtheria, Tetanus, Pertussis ³				DTaP	DTaP	DTaP	<i>see footnote 3</i>	DTaP				DTaP
<i>Haemophilus influenzae</i> type b ⁴				Hib	Hib	Hib ⁴		Hib				
Pneumococcal ⁵				PCV	PCV	PCV		PCV			PPSV	
Inactivated Poliovirus				IPV	OPV			OPV			OPV	
Influenza ⁶							Influenza (Yearly)					
Measles, Mumps, Rubella ⁷							MMR		<i>see footnote 7</i>			MMR
Varicella ⁸							Varicella		<i>see footnote 8</i>			Varicella
Hepatitis A ⁹							HepA (2 doses)				HepA Series	
Meningococcal ¹⁰											MCV	

 Range of recommended ages

 Certain high-risk groups

Why might some adults need vaccines?


- Some adults incorrectly assume that the vaccines they received as children will protect them for the rest of their lives. Generally this is true, except that:
- Some adults were never vaccinated as children
- Newer vaccines were not available when some adults were children
- Immunity can begin to fade over time
- As we age, we become more susceptible to serious disease caused by common infections (e.g., flu, pneumococcus)


Recommended Adult Immunization Schedule

Figure 1. Recommended adult immunization schedule, by vaccine and age group

VACCINE ▼	AGE GROUP ▶	19–26 years	27–49 years	50–59 years	60–64 years	≥65 years
Tetanus, diphtheria, pertussis (Td/Tdap) ^{1,*}		Substitute 1-time dose of Tdap for Td booster; then boost with Td every 10 yrs				Td booster every 10 yrs
Human papillomavirus (HPV) ^{2,*}		3 doses (females)				
Varicella ^{3,*}		2 doses				
Zoster ⁴					1 dose	
Measles, mumps, rubella (MMR) ^{5,*}		1 or 2 doses		1 dose		
Influenza ^{6,*}		1 dose annually				
Pneumococcal (polysaccharide) ^{7,8}		1 or 2 doses				1 dose
Hepatitis A ^{9,*}		2 doses				
Hepatitis B ^{10,*}		3 doses				
Meningococcal ^{11,*}		1 or more doses				

*Covered by the Vaccine Injury Compensation Program.

 For all persons in this category who meet the age requirements and who lack evidence of immunity (e.g., lack documentation of vaccination or have no evidence of prior infection)

 Recommended if some other risk factor is present (e.g., on the basis of medical, occupational, lifestyle, or other indications)

 No recommendation

Figure 2. Vaccines that might be indicated for adults based on medical and other indications

INDICATION ► VACCINE ▼	Pregnancy	Immuno-compromising conditions (excluding human immunodeficiency virus [HIV]) ¹¹	HIV infection ^{9,12,13}		Diabetes, heart disease, chronic lung disease, chronic alcoholism	Asplenia ¹⁴ (including elective splenectomy and terminal complement component deficiencies)	Chronic liver disease	Kidney failure, end-stage renal disease, receipt of hemodialysis	Health-care personnel
			CD4+ T lymphocyte count <200 cells/μL	≥200 cells/μL					
Tetanus, diphtheria, pertussis (Td/Tdap) ^{1,15}	Td	Substitute 1-time dose of Tdap for Td booster; then boost with Td every 10 yrs							
Human papillomavirus (HPV) ^{2,16}		3 doses for females through age 26 yrs							
Varicella ^{3,17}	Contraindicated	2 doses							
Zoster ⁴	Contraindicated	1 dose							
Measles, mumps, rubella (MMR) ^{5,18}	Contraindicated	1 or 2 doses							
Influenza ^{6,19}	1 dose TIV annually								1 dose TIV or LAIV annually
Pneumococcal (polysaccharide) ^{7,8}	1 or 2 doses								
Hepatitis A ^{9,20}	2 doses								
Hepatitis B ^{10,21}					3 doses				
Meningococcal ^{11,22}	1 or more doses								

^{*}Covered by the Vaccine Injury Compensation Program.

Yellow box: For all persons in this category who meet the age requirements and who lack evidence of immunity (e.g., lack documentation of vaccination or have no evidence of prior infection)

Purple box: Recommended if some other risk factor is present (e.g., on the basis of medical, occupational, lifestyle, or other indications)

White box: No recommendation

Pharmacist Role

- Advocacy
- Facilitation
- Vaccine administration