**Immunization**

Immunization is one of the most beneficial and cost-effective disease prevention measures. As a result of effective and safe vaccines, smallpox has been eradicated, polio is close to worldwide eradication.

Immunization is the process of inducing immunity against a specific disease. Immunity can be induced either **passively** through administration of antibody-containing preparations or **actively** by administering a vaccine or toxoid to stimulate the immune system to produce a prolonged humoral and/or cellular immune response.

**PASSIVE IMMUNITY**

Passive immunity is achieved by administration of preformed antibodies to induce transient protection against an infectious agent. Passive immunity also can be induced naturally through transplacental transfer of maternal antibodies (IgG) during gestation. This transfer can provide protection during an infant's 1st few mo of life; other antibodies (IgA) are transferred to the infant during breastfeeding. Protection for some diseases can persist for as long as 1 yr after birth, depending on the quantity of antibody transferred and the time until levels fall below those considered protective.

Passive immunity can be divided in to following types:

A- Anti-toxins ; derived from hoarse serum used for prophylaxis and treatment of tetanus , diphtheria & others ,great care must be exercised before administering animal-derived antisera because of the potential for severe allergic reactions. Due caution includes testing for sensitivity before administration, desensitization if necessary, and treating potential reactions, including febrile events, serum sickness, and anaphylaxis.

B- Immunoglobulins , administered intramuscularly (**IGIM** ), intravenously (**IGIV** ), or subcutaneously (**IGSC** )

used for:

1. Prophylaxis against infections such as chicken pox and measles.
2. Immunodeficiencies in children with B-lymphocyte defects who have difficulty making antibodies (e.g., hypogammaglobulinemia, secondary immunodeficiencies),
3. who have exposure to infectious diseases or to imminent risk of exposure when there isinadequate time for them to develop an active immune response to a vaccine

(e.g., newborn exposed to maternal hepatitis B),

4- who have infectious diseases that require antibody administration as part of the specific therapy e.g treatment of tetanus, infant botulism.

5- Treatment of many other medical condition like ,Gullain- Barrie syndrome, Immune- mediated thrombocytopenia (I.T.P) and neonatal septicemia.

C- Specific or hyperimmune immunoglobulin preparations administered IM or IV

D- Monoclonal Antibodies ( mAbs) which are antibody preparations produced against a single antigen e.g. **Palivizumab** is used for prevention of severe disease from respiratory syncytial virus (RSV) among children ≤24 mo old with bronchopulmonary dysplasia (BPD, a form of chronic lung disease), a history of premature birth, or congenital heart lesions or neuromuscular diseases. Monoclonal antibodies also are used to prevent transplant rejection and to treat some types of cancer, autoimmune diseases, and asthma. Adverse reactions to mAbs directed at modifying the immune response, such as antibodies against IL-2 or TNF-α, can be more serious and include cytokine release syndrome,fever, chills, tremors, chest pain, immunosuppression, and infection with various organisms, including mycobacteria.

**ACTIVE IMMUNIZATION**

Involves stimulating the immune system to produce either antibodies or cellular immune responses that protect against the infectious agents.

**Vaccines** are defined as whole or parts of microorganisms administered to prevent an infectious disease. Vaccines can consist of whole inactivated microorganisms (polio and hepatitis A), parts of the organism (acellular pertussis, hepatitis B), polysaccharide capsules (pneumococcal and meningococcal polysaccharide vaccines), polysaccharide capsules conjugated to protein carriers (Hib, pneumococcal, and meningococcal conjugate vaccines), live attenuated microorganisms (measles, mumps, rubella, varicella, rotavirus, and influenza vaccines).

A **toxoid** is a modified bacterial toxin that is made nontoxic but is still able to induce an active immune response against the toxin (tetanus and diphtheria)

Vaccines can contain a variety of other constituents besides the immunizing antigen. *Suspending fluids* may be sterile water or saline but can be a complex fluid containing small amounts of proteins or other constituents used to grow the immunobiologic culture. *Preservatives, stabilizers,* and *antimicrobial agents* are used to inhibit bacterial growth and prevent degradation of the antigen.Vaccines can induce immunity by stimulating antibody formation, cellular immunity, or both.These T-lymphocyte–dependent responses tend to induce high levels of functional antibody with high avidity.

Assessment of the immune response to most vaccines is performed by measuring serum antibodies. Although detection of serum antibody at levels considered protective after vaccination can indicate immunity, loss of detectable antibody over time does not necessarily mean susceptibility to disease.

**Live-attenuated vaccines** tend to induce long-term immune responses. They replicate, often similarly to natural infections, until an immune response inhibits reproduction. Most live vaccines are administered in 1-dose or 2-dose schedules. The purpose of repeat doses, such as a 2nd dose of the MMR or MMRV (MMR+Varcilla) vaccine, is to induce an initial immune response in those who failed to respond to the 1st dose.

**Inactivated vaccines** tend to require multiple doses to induce an adequate immune response and are more likely than live-attenuated vaccines to need booster doses to maintain that immunity.

However, some inactivated vaccines appear to induce long-term or perhaps lifelong immunity, after a primary series, including hepatitis B vaccine and inactivated polio vaccine.

**BCG vaccine**

The only available vaccine against tuberculosis is the BCG vaccine.It is a live attenuated strain of Mycobacterium bovis known as Bacillus Calmette-Guérin (BCG) uses shared antigens to stimulate the development of cross-immunity to Mycobacterium tuberculosis. It lost its virulence in humans by being specially cultured in an artificial medium for years, which gives considerable protection against TB.It is given routinely to all newborns, when vaccination is delayed to end of first year prior tuberculin testing is important, vaccine can be given to tuberculin negative children and to adolescent.

The dose is 0.1ml intradermal in the deltoid region; successful vaccine produces a small indurated area (2-4mm), after 3-4weeks the lesion progresses to a papule or shallow ulcer of approximately 10 mm diameter and heals within 12 weeks to form a small, flat scar.

Side effects

local abscess, axillary lymphadenitis, allergy, dizziness, vertigo, keloid scarring. No live vaccine should be given within 3weeks except (OPV) and there be no vaccination in the same area for 3months.BCG is contraindicated in profoundly immunocompromised patients (including HIV) because they can develop disseminated TB infection.

Unfortunately, BCG vaccine does not give complete protection from TB disease throughout life. It has been suggested that BCG is only 50% effective in preventing pulmonary TB and slightly higher (50-80%) in preventing disseminated and meningeal TB. A variety of explanations for the varied responses to BCG vaccines have been proposed, including methodologic and statistical variations within the trials, interaction with NTM (nontuberculous mycobacterium) that either enhances or decreases the protection afforded by BCG, different potencies among the various BCG vaccines, and genetic factors for BCG response within the study populations.

Most reactions are mild and usually resolve spontaneously, but chemotherapy is needed occasionally.Surgical excision of a suppurative draining node is rarely necessary and should be avoided if possible.. Systemic complaints such as fever, convulsions, loss of appetite, and irritability are extraordinarily rare after BCG vaccination. Profoundly immunocompromised patients can develop disseminated BCG infection after vaccination. Children with HIV infection appear to have rates of local adverse reactions to BCG vaccines that are comparable with rates in immunocompetent children. Recommended vaccine schedules vary widely among countries. The official WHO recommendation is a single dose administered during infancy, in populations where the risk for tuberculosis is high. However, *infants with known* *or suspected HIV infection should not receive a BCG vaccination.* In some countries, repeat vaccination is universal, although no clinical trials support this practice. In others, it is based on either TST or the absence of a typical scar.

BCG vaccination administered during infancy has little effect on the ultimate incidence of tuberculosis in adults,suggesting waning protection with time.

After receiving the vaccine, the child should be separated from the possible sources of infection until it can be demonstrated that the child has had a vaccine response, demonstrated by tuberculin reactivity, which usually develops within 1-3 mo.

**Polio vaccines**

The two vaccines have eradicated polio from most of the countries in the world and reduced the worldwide incidence from an estimated 350,000 cases in 1988 to less than 2000 cases in 2008.

Salk’s Polio vaccine “Inactivated Polio Vaccine” IPV injectable, It Contains 3 serotypes of vaccine virus, the injected Salk vaccine confers IgG-mediated immunity in the bloodstream, which prevents polio infection from progress to viremia and protects the motor neurons, thus eliminating the risk of bulbar polio and post-polio syndrome. It offers no protection to the mucosal lining of the intestine.

IPV has essentially no adverse effects associated with it other than possible rare hypersensitivity reactions. The immunogenicity of IPV is not affected by the presence of maternal antibodies, and IPV has no adverse effects.

Sabin's polio vaccine “Oral live-attenuated vaccine” is a live-attenuated vaccine, contains 3 serotypes of vaccine virus, It replicates very efficiently in the gut producing( mucosal IgA immunity), the primary site of infection and replication, Unable to replicate efficiently within nervous system tissue, Shed in stool for up to 6 weeks following vaccination.

The OPV proved to be superior in administration, and also provided longer lasting immunity than the Salk vaccine. Oral Polio Vaccine on very rare occasions has been associated with paralysis (vaccine-associated paralytic poliomyelitis), about 1 case per 750,000 vaccine recipients in the United States to 1 in 143,000 immunized infants in India. As long as the OPV is being used, there is the potential that vaccine-derived poliovirus (VDPV) will acquire the neurovirulent phenotype and transmission characteristics of the wild-type polioviruses. VDPV emerges from the OPV because of continuous replication in immunodeficient persons (iVDPV) or by circulation in populations with low vaccine coverage (cVDPVs). The risk was highest with the type 2 strain.

It is given in 3doses, each of 2drops (oral) at age of 2, 4, 6 months. A booster dose is given at age of (1.5-2years). 2nd booster dose is given at age of 4-6yrs. It is C/I in immunocompromised persons & their household contacts because of the risk of VAPP, these should receive only IPV.

**DTaP vaccine**

Diphtheria and tetanus toxoids combined with acellular pertussis vaccines (DTaP) are licensed in children younger than 7 yrs of age. DTaP vaccines have fewer adverse effects than the vaccines containing whole-cell pertussis (DTP), dose is 0.5ml IM given to all infants.

Two preparations of diphtheria toxoids , The pediatric (6 mo to 6 yr) preparations (i.e., **DTaP** [diphtheria and tetanus toxoids with acellular pertussis vaccine], **DT** [diphtheria and tetanus toxoids vaccine]) contain 6.7-25.0 Lf units of diphtheria toxoid per 0.5 mL dose; the adult preparation (Td; 10% of pediatric diphtheria toxoid dose, Tdap [diphtheria and tetanus toxoids with acellular pertussis vaccine]) contain no more than 2-2.5 Lf units of toxoid per 0.5 mL dose. The *higher-potency* (D) formulation of toxoid is used for primary series and booster doses for children through 6 yr of age because of superior immunogenicity and minimal reactogenicity. For individuals ≥7 yr old, Td is recommended for the primary series and booster doses because the lower concentration of diphtheria toxoid is adequately immunogenic and increasing the content of diphtheria toxoid heightens reactogenicity with increasing age.

For children 6 wk to 6 yr of age, five 0.5 mL doses of diphtheria-containing (D) vaccine (DTaP preferred) are given in the primary series, including doses at 2, 4, and 6 mo of age, and a 4th dose, an integral part of the primary series, at 15-18 mo. A booster dose is given at 4-6 yr of age.For persons ≥7 yr old not previously immunized for diphtheria, three 0.5 mL doses of *lower-level* diphtheria-containing (d) vaccine are given in a primary series of 2 doses at least 4 wk apart and a 3rd dose 6 mo after the 2nd dose. The 1st dose should be Tdap, and subsequent doses should be Td. **The only contraindication to tetanus and diphtheria toxoid is a history of neurologic or severe hypersensitivity reaction after a prior dose**. For children <7 yr old in whom pertussis immunization is contraindicated, DT is used. Those whose immunization is begun with DTaP or DT before 1 yr of age should have a total of five 0.5 mL doses of diphtheria-containing (D) vaccines by 6 yr of age. For those whose immunization is begun at around 1 yr old, the primary series is three 0.5 mL doses of diphtheria-containing (D) vaccine, with a booster given at 4-6 yr, unless the 3rd dose was given after the 4th birthday.

A booster dose, consisting of the adult preparation of Tdap, is recommended at 11-12 yr of age. Adolescents 13-18 yr old who missed the Td or Tdap booster dose at 11-12 yr or in whom it has been ≥5 yr since the Td booster dose also should receive a single dose of Tdap if they have completed the DTP/DTaP series.

There is no association of DT or Td with convulsions. Local adverse effects alone do not preclude continued use. The rare patient who experiences an Arthus-type hypersensitivity reaction or a temperature >39.4°C (103°F) after a dose of Td usually has high serum tetanus antitoxin levels and should not be given Td more frequently than every 10 yr, even if the patient sustains a significant tetanus-prone injury. The DT or Td preparation can be given concurrently with other vaccines.

 Minor reactions are quite frequent in 20–50% of vaccines. Local reactions ,

inflammation, induration or a painless nodule at the site of injection. These are progressively more common after the first injection

 Moderate reactions occur in 0.1% to 1.0% of children and include:

1. ongoing crying (for three hours or more in the first 12 hours)

2. a high fever (up to 40°C)

3. an unusual (screaming), high-pitched crying

 Severe problems happen very rarely (1 in 140,000 cases of DPT). Include;

1. Serious allergic reaction,

2. prolonged seizures,

3. Encephalopathy, or even death.

For children less than 7 yrs of age in whom pertussis immunization is contraindicated, DT is used.

dT vaccine(adult preparation): It is a mixture of toxoid of diphtheria &tetanus is given to children ≥ 7years of age, as pertussis vaccine is contraindicated after this age. Dose 0.5ml IM.

Contraindications to DTaP vaccination:

1. Severe allergic reaction (e.g., anaphylaxis) after a previous dose or to a vaccine component.

2. Encephalopathy (e.g., coma, decreased level of consciousness, prolonged seizures), not attributable to another identifiable cause, within 7 days of administration of previous dose of DTP or DTaP.

**Measles vaccine**

It is a live attenuated vaccine given to all infants at age of 9-12months. But it can be given to children & adolescent too.

Dose 0.5ml subcutaneously (single dose). It is generally safe vaccine, in children with egg allergy &asthmatic patient it should be given under hospital supervision.

**MMR vaccine**

It is a mixture of 3 vaccines (live attenuated of measles, mumps &rubella).

It is given to children at age of 12-15mo, it can also be given to older children, A booster dose at age of 4-6years is currently recommended. Seroconversion is slightly lower in children who receive the 1st dose before or at 12 mo of age because of persisting maternal antibody.However, the 2nd dose can be given any time after 30 days following the 1st dose.For children who have not received 2 doses by 11-12 yr of age, a 2nd dose should be provided. Infants who receive a dose before 12 mo of age should be given 2 additional doses at 12-15 mo and 4-6 yr of age. Children who are traveling should be offered either primary measles immunization even as young as 6 mo or a 2nd dose even if <4 yr.

Dose is 0.5ml subcutaneously (single dose),the vaccine is safe. Because MMR is a live-attenuated vaccine, adverse events from the measles-mumps-rubella vaccine include fever (usually 6-12 days following vaccination), rash in approximately 5% of vaccinated persons, and, rarely, transient thrombocytopenia .

Children prone to febrile seizures may experience an event following vaccination, so the risks and benefits of vaccination should be discussed with parents. Encephalopathy and autism have not been shown to be causally associated with the measles-mumps-rubella vaccine or vaccine constituents.

A review of the effect of measles vaccination on the epidemiology of SSPE has demonstrated that measles vaccination protects against SSPE and does not accelerate the course of SSPE or trigger the disease in those already infected with wild measles virus.

Passively administered immune globulin may inhibit the immune response to live measles vaccine, and administration should be delayed for variable amounts of time based on the dose of Ig.e.g tetanus, hepatitis A, hep.B Ig, the interval should be 3 month to receive the vaccine, while it reach up to 11 month after receiving IG in Kawasaki disease or 8 month after ITP.

Contraindications and Precautions

* MMR vaccine should not be administered if there is severe allergic reaction to vaccine component or following prior dose.
* MMR is a live vaccine so should not be administered to pregnant women or to immunodeficient or immunosuppressed patients. However, patients with HIV who are not severely immunocompromised should be immunized with measles vaccine.
* Severe hypersensitivity (anaphylaxis) to neomycin or gelatin.
* Personal or family history of seizures can immunize; but advise parents of slightly increased risk of seizures
* Because measles virus may suppress the cutaneous response to tuberculosis antigen, skin testing for tuberculosis should be performed before or at the same time as administration of the vaccine. Individuals infected with *M. tuberculosis* should be receiving appropriate treatment at the time of administration of measles vaccine.
* In case of Allergy to eggs can be Immunized; no reactions likely

**Hepatitis B vaccine**

It is a recombinant DNA vaccine contains purified HBsAg particles of viruses (inactivated viral antigen).

Vaccine usually is given intramuscularly as a three-dose series (0, 1, and 6 mo). Three doses induce seroconversion in 90-95% of healthy infants, children and adults. Dose for infants and children is 0.5ml IM (not in the buttock). Current vaccination recommendations are as follows:

1.For all medically stable infants weighing >2,000 g at birth and born to HBsAg-negative mothers, the 1st dose of HBV vaccine should be administered before hospital discharge; single-dose antigen HBV vaccine should be used for the birth dose. Subsequent doses to complete the series are given at 1–4 mo, and at 6–18 mo of age (0,1,6).

2.Preterm infants weighing <2,000 g at birth and born to HBsAg-negative

mothers should have their initial dose delayed until 1 mo of age or before hospital discharge.

Seropositivity is >95% with all vaccines, achieved after the second dose in most patients. The third dose serves as a booster and may have an effect on maintaining long-term immunity. In immunosuppressed patients and infants whose birthweight is <2,000 g, a fourth dose is recommended (the birth dose does not count as part of the 3-dose series) and these infants should be checked for anti-HBs and HBsAg after completing these shots. In this group of infants, if the anti-HBs level is <10 mIU/mL, they should repeat the 3-dose series. Despite declines in the anti-HBs titer in time, most healthy vaccinated persons remain protected against HBV infection.

3. Infants born to HBsAg-positive women should receive vaccine at birth, 1–2 mo, and 6 mo of age. The 1st dose should be accompanied by administration of HBIG as soon after delivery as possible (within 12 hrs) because the effectiveness decreases rapidly with increased time after birth.

Postvaccination testing for HBsAg and anti-HBs should be done at 9–18 mo.:

 If the result is positive for anti-HBs → the child is immune.

 If the result is positive for HBs Ag only → the parent should be counseled and the child evaluated by pediatric gastroenterologist.

 If the result is negative for both HBs Ag & anti-HBs → 2nd complete hepatitis B vaccine series should be administered, followed by testing for anti-HBs to determine if subsequent doses are needed.

It is indicated in children & adults who are at risk of infection especially health care personnel and patients subjected to repeated blood transfusion.

Side effects

Transient erythema and induration at the site of injection ( 29%), fever(6%), malaise, flu-like illness, arthritis, myalgia and arthralgia.

**Rotavirus vaccine**

In early childhood, the single most important cause of severe dehydrating diarrhea is Rota virus infection. The vaccine protects against Rota virus gastroenteritis, oral route, three doses; 2,4, and 6 months,

Immunization should not be initiated for infants 15 wks of age and older and the final dose in the series must be administered no later than 8 mo of age.

Rotavirus vaccine did not increase the risk for intussusception.

A live, oral, pentavalent rotavirus vaccine was approved in 2006. The vaccine contains five reassortant rotaviruses isolated from human and bovine hosts. The pentavalent vaccine protects against rotavirus gastroenteritis when administered as a threedose series at 2, 4, and 6 mo of age. The first dose should be administered between 6 and 12 wk of age, with all three doses completed by 32 wk of age.

The vaccine provides substantial protection against rotavirus gastroenteritis, with a primary efficacy of 98% against severe rotavirus gastroenteritis caused by G1-G4 serotypes and 74% efficacy against rotavirus gastroenteritis of any severity through the first rotavirus season after vaccination. It provides a 96% reduction in hospitalizations for rotavirus gastroenteritis through the first 2 yr after the third dose.

Another new monovalent rotavirus vaccine was licensed and appears to be safe and effective. It is an attenuated monovalent human rotavirus and is administered as two oral doses at 2 and 4 mo of age. The vaccine has 85% efficacy against severe gastroenteritis and was found to reduce hospital admissions for all diarrhea by 42%. Despite being monovalent, the vaccine is effective in prevention of all four common serotypes of human rotavirus.

Studies from several developed countries show greater than 90% protection against severe rotavirus disease. Studies from developing countries show 50– 60% protection from severe disease. Vaccine-associated disease has been reported in vaccine recipients who have severe combined immunodeficiency disease (a contraindication). In addition, *vaccine-derived virus may undergo reassortment and become more virulent, producing diarrhea in unvaccinated siblings*.

**Meningococcal vaccine**

Meningococcal vaccine refers to any of vaccines used to prevent infection by Neisseria meningitides. It includes: meningococcal polysaccharide vaccine (MPSV) and meningococcal conjugate vaccine .

polysaccharide vaccines are poorly immunogenic in infants, do not induce immunologic memory, and are associated with *immunologic hyporesponsiveness* (reduced response to future doses of polysaccharide). Plain polysaccharide vaccines have been superseded by meningococcal protein-polysaccharide *conjugate vaccines* , which are generally more immunogenic than plain polysaccharides, are immunogenic from early infancy, induce immunologic memory, and are not associated with hyporesponsiveness. The conjugate vaccines contain meningococcal polysaccharides that are chemically conjugated to a carrier protein. Three carrier proteins are used in various meningococcal conjugate vaccines: tetanus toxoid, diphtheria toxoid, and the mutant diphtheria toxin, CRM197

Meningococcal vaccine 4 doses of MenACWYCRM is recommended for children 2 months through 10 years old who are at increased risk for meningococcal disease due to certain medical conditions (functional or anatomic asplenia, HIV, terminal complement or properdin deficiency ( x-linked immunedeficiency with recurrent meningococcal disease with case fatality up to 75%) , people who are traveling to a country with high rates of meningococcal disease, or because of an outbreak in their community.

Meningococcal vaccine MenACWYCRM or MenACWYD is routinely recommended also for all 11 through 18 year olds. The first dose should be given at 11-12 years old and a booster dose at 16 years old. Adolescents who receive their first dose of quadrivalent meningococcal conjugate vaccine at or after 16 years old do not need a booster dose. Dose 0.5ml S.C .

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**Hemophilus influenza type b vaccine**

It is indicated for prevention of invasive diseases caused by H.influenza especially meningitis, septicemia, epiglottitis, arthritis &cellulitis. Dose 0.5ml IM or SC.

Doses of Hib vaccine are usually recommended at these ages:

First Dose: 2 months of age

Second Dose: 4 months of age

Third Dose: 6 months of age

Final/Booster Dose: 18 months of age

Children over 5 years old and adults usually do not need Hib vaccine. But it may be recommended for older children or adults with asplenia or sickle cell disease, before surgery to remove the spleen, or following a bone marrow transplant. It may also be recommended for people 5 to 18 years old with HIV.

The Hib conjugate vaccines stimulate circulating anticapsular antibody and provide long-term immunity through B-cell memory

**Pneumococcal vaccine**

Streptococcus pneumonia is the leading cause bacterial pneumonia , bacteremia and bacterial meningitis in children.

2 types: Conjugate and Polysaccharide type

Administer a 4-dose series of PCV-13 (pneumococcal conjugate vaccine) at ages 2, 4, and 6 months and at age 12 through 15 months.(in Iraq 2,4,6 mo).

PCVs provoke protective antibody responses in 90% of infants given these vaccines at 2, 4, and 6 mo of age, and greatly enhanced responses (e.g.,immunologic memory) are apparent after vaccine doses given at 12-15 mo of age .In a large clinical trial, PCV7 was shown to reduce invasive disease caused by vaccine serotypes by up to 97% and to reduce invasive disease caused by all serotypes, including serotypes not in the vaccine, by 89%. Rates of hospitalization for pneumococcal pneumonia among U.S. children decreased after PCV13 introduction. The number of cases of pneumococcal meningitis in children remain unchanged, but the proportion of PCV13 serotypes have decreased significantly. In addition, pneumococcal conjugate vaccines significantly reduce nasopharyngeal carriage of vaccine serotypes and have decreased rates of invasive pneumococcal disease in children with sickle cell disease. Adverse events after the administration of PCV have included local swelling and redness and slightly increased rates of fever, when used in conjunction with other childhood vaccines.

Immunologic responsiveness and efficacy after administration of pneumococcal polysaccharide vaccines (PPSV23) is unpredictable in children <2 yr old. PPSV23 contains purified polysaccharide of 23 pneumococcal serotypes responsible for >95% of invasive disease. The clinical efficacy of PPSV23 is controversial, and studies have yielded conflicting results.

Immunization with PCV13 is recommended for all infants on a schedule for primary immunization, in previously unvaccinated infants, and for transition for those partially vaccinated with PCV7 . High-risk children ≥2 yr old, such as those with asplenia, sickle cell disease, some types of immune deficiency (e.g., antibody deficiencies), HIV infection, cochlear implant, CSF leak, diabetes mellitus, and chronic lung, heart, or kidney disease (including nephrotic syndrome), may benefit also from PPSV23 administered after 2 yr of age following priming with the scheduled doses of PCV13. Thus, it is recommended that children 2 yr of age and older with these underlying conditions receive supplemental vaccination with PPSV23. A 2nd dose of PPSV23 is recommended 5 yr after the 1st dose of PPSV23 for persons ≥2 yr old who are immunocompromised, have sickle cell disease, or functional or anatomic asplenia. Additional recommendations have been made for at-risk children 6-18 yr old .

High-risk children age 2 yrs and older should receive the PPSV (pneumococcal polysaccharide vaccine) 8 weeks or more after their last PCV dose, those children are with certain health conditions including:

* **Immunocompetent persons**

Chronic heart disease

Chronic lung disease

Diabetes mellitus

Cerebrospinal fluid leaks

Cochlear implants

Chronic liver disease

Cigarette smoking

* **Persons with functional or anatomic asplenia**

Sickle cell disease,other

hemoglobinopathies

Congenital or acquired asplenia

Immunocompromised

persons

* **Congenital or acquired immunodeficiencies**

HIV infection

Chronic renal failure

Nephrotic syndrome

Leukemia

Lymphoma

Hodgkin disease

Generalized

malignancy

Iatrogenic immunosuppression

Solid-organ transplant

Multiple myeloma

**Influenza vaccine**

Influenza vaccine is recommended for all children beginning at 6 mo of age, with a minimum age of 6 mo . There are two types: IIV (Inactivated Influenza vaccine) which is given intramuscularly and LAIV (Live attenuated influenza vaccine) by intranasal route.

Children 6 mo of age through 8 yrs of age should receive 2 doses of vaccine at least 1 mo apart.

Vaccine effectiveness can vary from year to year and among different age and risk groups. Recommendations for use of the influenza vaccine have broadened as the impact of influenza is appreciated in such groups as pregnant women and young infants.

It was recommended that all children from 6 mo to 18 yr of age be vaccinated for influenza unless they have a specific contraindication to receiving the vaccine. To protect infants younger than 6 mo who are too young to receive vaccine, household contacts and out-of-home caregivers are groups for whom additional vaccination efforts should be made. Chemoprophylaxis with antiviral medications is a secondary means of prevention and is not a substitute for vaccination.

There are 2 main categories of seasonal influenza vaccines available for children: inactivated influenza vaccine (IIV) and live-attenuated influenza vaccine (LAIV). Previously referred to as the trivalent inactivated vaccine, IIV is given intramuscularly; it uses killed virus components. The LAIV vaccine uses weakened influenza virus and is administered as an intranasal spray. Neither IIV nor LAIV can cause influenza.

Special vaccination instructions for children 6 mo to 8 yr of age should be followed: children in this age group who have not previously received a total of ≥2 previous doses of trivalent or quadrivalent vaccine require 2 doses (at least 4 weeks apart) of the current season's influenza vaccine to optimize immune response . Influenza vaccines have an excellent safety profile, with the most common side effects being soreness, redness, tenderness, or swelling from the injection, and nasal congestion after the nasal spray.

Seasonal influenza vaccines become available in the late summer and early fall each year. The formulation reflects the strains of influenza viruses that are expected to circulate in the coming influenza season.

Ideally, vaccination should be given before the onset of influenza circulation in the community, so that there is time for antibodies to reach protective levels. Healthcare providers should offer vaccination by the end of October, if possible.

Indicated in:

1. Immunosuppression

2. Cardiac disease

3. Chronic lung diseases

4. Chronic renal diseases

5. Hemoglobinopathy

6. Long term Aspirin treatment

7. Chronic metabolic diseases

8. Given in epidemic

9. Diabetes mellitus

**Rabies vaccine**

Inactivated virus vaccine, human diploid cell vaccine (HDCV) is available given intramuscularly.

**Post exposure prophylaxis** in both children and adults is given as 4 doses (1 mL) of vaccine on days 0, 3, 7, and 14. Injection into the gluteal area is associated with a blunted antibody response, so this area should not be used. The rabies vaccines can be safely administered during pregnancy. In most persons the vaccine is well tolerated; most adverse effects are related to

booster doses. Pain and erythema at the injection site occur commonly, and local adenopathy, headache, and myalgias occur in 10–20% of patients. Approximately 5% of patients who receive the human diploid cell vaccine experience an immune complex–mediated allergic reaction, including rash, edema, and arthralgias, several days after a booster dose. The World Health Organization has approved schedules using smaller amounts of vaccine, administered intradermally, that are immunogenic and protective but none is approved for use in the United States.

**Preexposure Prophylaxis**

The killed rabies vaccine can be given to prevent rabies in persons at high risk for exposure to wild-type virus, including laboratory personnel working with rabies virus, veterinarians, and others likely to be exposed to rabid animals as part of their occupation. persons traveling to a rabies-endemic region where there is a credible risk for a bite or scratch from a rabies-infected animal. The schedule for preexposure prophylaxis consists of three intramuscular injections on days 0, 7, and 21 or 28. PEP in the patient who has received preexposure prophylaxis or a prior full schedule of PEP consists of two doses of vaccine (one each on days 0 and 3) and does not require RIG. Immunity from preexposure prophylaxis wanes after several years and requires boosting if the potential for exposure to rabid animals recurs.

**Varicella vaccine**

Varicella is a vaccine-preventable disease. Varicella vaccine contains live, attenuated VZV (Oka strain) and is indicated for subcutaneous or IM administration(0.5ML). varicella vaccine is recommended for routine administration as a 2-dose regimen to healthy children at ages 12-15 mo and 4-6 yr.

Administration of the 2nd dose earlier than 4-6 yr of age is acceptable, but it must be at least 3 mo after the 1st dose. Catch-up vaccination with the 2nd dose is recommended for children and adolescents who received only 1 dose.

Vaccination with 2 doses is recommended for all persons without evidence of immunity. The minimum interval between the 2 doses is 3 mo for persons 12 yr of age or younger and 4 wk for older children, adolescents, and adults.

Administration of varicella vaccine within 4 wk of measles-mumps-rubella (MMR) vaccination is associated with a higher risk for breakthrough disease; therefore, *it is recommended that the varicella and MMR vaccines either be administered simultaneously at different sites or be given at least 4 wk apart*.

Varicella vaccine can be administered as a monovalent vaccine (for all healthy persons ≥12 mo of age) or as the quadrivalent measles-mumps-rubella-varicella (MMRV) vaccine (for children age 12 mo through 12 yr only).

Varicella vaccine is contraindicated for persons who have a history of anaphylactic reaction to any component of the vaccine; pregnant women; persons with cell-mediated immune deficiencies, including those with leukemia, lymphoma, and other malignant neoplasms affecting the bone marrow or lymphatic systems; persons receiving immunosuppressive therapy; and persons who have a family history of congenital or hereditary immunodeficiency in 1stdegree

relatives unless the immune competence of the potential vaccine recipient is demonstrated. Children with isolated humoral immunodeficiencies may receive varicella vaccine.

Varicella vaccine can be administered to patients with leukemia, lymphoma, or other malignancies whose disease is in remission, who have restored immunocompetence, and whose chemotherapy has been terminated for at least 3 mo.

The vaccine should be considered for HIV-infected children with a CD4+ Tlymphocyte percentage ≥15%. These children should receive 2 doses of vaccine, 3 mo apart.

Avoid using Salicylates for 6 weeks after getting Varicella vaccine; this is because of the potential risk of Reye syndrome

**Hepatitis A vaccine**

Hepatitis A vaccine, inactivated virus, licensed for administration to children 12 mo of age and older, is recommended for universal administration to all children at 12 through 23 mo of age and for certain high-risk groups.

The availability of 2 inactivated, highly immunogenic, and safe HAV vaccines has had a major impact on the prevention of HAV infection. Both vaccines are approved for children older than 12 mo. They are administered intramuscularly in a 2-dose schedule, with the second dose given 6-12 mo after the first dose. Seroconversion rates in children exceed 90% after an initial dose and approach 100% after the second dose; protective antibody titer persists for longer than 10 yr in most patients. The immune response in immunocompromised persons, older patients, and those with chronic illnesses may be suboptimal; in those patients, combining the vaccine with Ig for pre- and postexposure prophylaxis is indicated. HAV vaccine may be administered simultaneously with other vaccines. A combination HAV and HBV vaccine is approved in adults older than age 18 yr. For healthy persons at least 12 mo old, vaccine is preferable to Ig for preexposure and postexposure prophylaxis .universal vaccination is now recommended for all children older than 12 mo. The vaccine is effective in curbing outbreaks of HAV because of rapid seroconversion and the long incubation period of the disease.

Vaccine given in 2 doses, should be separated by at least 6 mo.

Dose 0.5ml IM (1-5yrs) of age, 1ml (adult)

Other Indications:

 Travel to endemic area

 During outbreak

 Persons with clotting-factor disorders, or chronic liver disease.

**Recent Vaccination Schedule in Iraq**

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**Contraindications & Precautions of Vaccinations**

1. Anaphylaxis to the vaccine (or any of its constitution) in the prior dose is an absolute contraindication to that vaccine.

The major constituents of concern are egg proteins for vaccines grown in eggs, measles and mumps components of MMR are grown in chick embryo fibroblast tissue culture. However, the amount of egg protein in MMR is so small as not to require any special procedures before administering vaccine to someone with a history of anaphylaxis following egg ingestion.

2. Immunodeficiency; patients with Cellular immune deficiency, should not be given Live attenuated vaccines but can receive all other types of vaccines.

\* Patients on Steroid therapy in dose <2 mg/kg/day can receive LAV during therapy, whereas patients on higher dose for ≥2 wk should receive LAV only after cessation of steroid Rx for at least 1 mo.

3. Patient with severe or moderate (but not mild) acute illness.

4. Preterm can be vaccinated at the same schedule of the full- term infants, except the birth dose of HBV can be deferred for 1 mo after birth if his mother has HBs Ag –ve.

5. Immunoglobulines may interfere with some vaccines e.g; Immunoglobulines should be administered at least 2 wk after measles vaccine.

6. Generally, all vaccines can be given simultaneously except that different LAV if not given simultaneously; they should be given at least 1 month apart due to a theoretical concern about viral interference.