# VACCINATION

Sarah Najim, MD

## Introduction

- **Immunization**: is a measure used to protect individuals by raising their resistance to infections.
- **Types of Immunity**:

1. **Natural immunity**, which includes:

- [ ] Passive: transplacental from mother to child
- [ ] Active: acquired after infection.

2. **Artificial immunity**, which includes:

- [ ] Passive: immunoglobulins and monoclonal antibodies.
- [ ] Active: vaccines.

- A **vaccine**: is a suspension of a live attenuated or killed MO administered to induce immunity.
- **Toxoid**: a modified bacterial toxin made to stimulate antibodies formation.
- **Immunoglobulins**: ready antibodies derived from human blood plasma.
- **Active immunization**: the patient produces his own immunity after vaccination with a vaccine or toxoid.
- **Passive immunization**: includes trans-placental transfer of maternal antibodies and the administration of antibodies, either as immunoglobulin or monoclonal antibody.
- **Herd immunity**: a form of immunity that occurs when the vaccination of a significant portion of a population provides a measure of protection for individuals who have not developed immunity.
- **Immunization Coverage Rate**: percent of the target population that has received the vaccine.
- **Naive**: a person who has not exposed to an infectious agent.

## Vaccines

- **Types of Vaccine:**

- [ ] **Live attenuated**:

1. Viral: **MMR**, rubella, varicella, nasal influenza, **OPV** and **rota vaccine**.
2. Bacterial: **BCG** , oral typhoid.

- [ ] **Inactivated or Killed**:

3. Inactivated whole organism (killed): **IPV**, **IM influenza**, HAV.
4. Recombinant products (DNA or mRNA amplification): HBV, HPV.
5. Immunogenic components of bacteria (certain antigen for example): pertussis.
6. Conjugated vaccine: ***H.influenzae*** type b, Neisseria meningitidis, **Streptococcus pneumoniae**.

## Immune Response to Vaccines

- In live attenuated vaccines, the organism multiply in recipient so it is more like the infection, and more likely to produce life-long protection after the 1st dose of vaccine.
- Killed vaccines: are less antigenic, usually need booster doses.
- Primary response to vaccines is IgM serum antibodies detected within 7-10 days then IgG type peaks at 2-6 weeks.
- T-cell independent antigens: antigens induce B cells proliferation and antibody production, without the help of T cells. T-cells independent antigens induce inadequate immune response at age < 2 years. The lack of immune response may be overcome by conjugating the polysaccharides to a carrier protein, e.g, Hib & Conjugated pneumococcal vaccines.

# Contraindications

## General Contraindications of All Vaccines

- Live attenuated vaccines are contraindicated in immunocompromised patients (HIV, stem cell transplant... etc)
- OPV is contraindicated in a child with immunocompromised contact.
- Any patient with a known anaphylactic reaction after a previous exposure to the same vaccine.
- For pertussis, if encephalopathy develops within 7 days, you should not provide additional doses of a vaccine that contains pertussis.
- Rotavirus vaccine should not be given to patients with a history of intussusception.
- Severe illness.

## General Side Effects of All Vaccines

- Local reactions.
- Anaphylaxis to vaccine components.
- Fever.
- Syncope.

# The Jordanian National Immunization Program

| Age | Vaccines |
|---|---|
| 0 - 1 month | BCG vaccine (for tuberculosis). |
| 2 months (61 days) | Hexa vaccine (IPV, DaTP, Hib, HBV) dose #1 and Rotavirus (dose #1), PCV (dose #1). |
| 3 months (91 days) | Hexa vaccine (IPV, DTaP, Hib, HBV) dose #2 and Rotavirus (dose #2) and OPV. |

| | |
|---|---|
| 4 months (121 days) | Hexa vaccine (IPV, DTaP, Hib, HBV) dose #3 and Rotavirus (dose #3) and OPV, PCV (dose #2). |
| 9 months (271 days) | Measles + Vit A 100,000 IU & OPV. |
| 1 year (12 months) | MMR (dose #1), HAV (dose #1), PCV (dose #3). |
| 1.5 years (18 months) | MMR (dose #2), DPT booster & OPV booster, HAV, Varicella + Vit A 200,000 IU. |
| 6 years (1st grade) | OPV, Td. |
| 15 years (10th grade) | Td. |

# Routes of administration of vaccines

- **IM:** most vaccines
- **Intradermal:** BCG
- **SC:** MMR
- **Oral:** OPV, rotavirus
- **Nasal:** flu (not available in Jordan, live vaccine)

# BCG (Bacille Calmette-Guerin) مطعوم التدرن أو السل

- Bacterial
- Live attenuated ***Mycobacterium Bovis*** (not tuberculosis) that induces the T cell response.
- BCG provides protection against TB meningitis (50-80%) and miliary disease.
- Doses: one dose is given within the 1st month of life.
- Route: intradermal (**the only vaccine administered intradermally**).
- Location: left shoulder/ Deltoid (look for a scar).
- Only 10% of the patients will not have a scar.
- BCG induces T cell response, therefore; its reaction won't be acute.

☐ 2 weeks after vaccine injection: Local lesion, and papule might develop.
☐ 4-6 weeks; Small abscess might develop.
☐ At 6 weeks: (crust, detaches, ulcerates), then a scar (typically round and slightly depressed) which remains.

## BCG Adverse Reactions

- Uncommon (1-2%).
- Local abscess (at the site of injection).
- "Not so serious" Lymphadenitis (axillary, cervical lymphadenopathy); Non-suppurative (no pus) or suppurative (contains pus).

- Serious Lymphadenitis: It can be persistent, axillary, large, recurrent or multiple (neck, axilla).
- BCG osteitis (affects the bone).
- Disseminated (generalized) BCGosis in immunocompromised.

## BCG Contraindications

- Skin disorders (burn, skin infection).
- Immune deficiency, immunosuppressive medications (like steroids).
- Pregnancy (in Jordan we don't see patients > 14 in the pediatrics department but in the USA they see).

# OPV/IPV (Poliovirus Vaccine) مطعوم شلل الأطفال

## Poliomyelitis

- Poliovirus is a non-enveloped ssRNA virus, of ***Picornaviridae*** family, genus Enterovirus, species enterovirus C, and has 3 serotypes.

☐ 70% of infections are asymptomatic
☐ 25% are sore throat & low-grade fever
☐ 1-5% viral meningitis (st. with paresthesia)
☐ <1% rapid-onset, asymmetric, acute flaccid paralysis of proximal muscles, areflexia, normal sensation, 2/3rds have residual paralysis.

## The Vaccine

- Virus:

☐ POLIOVIRUS: enterovirus RNA virus of Picornavirus family, it is the leading cause of **poliomyelitis** (asymmetrical paralysis).

- Types :

☐ OPV: live attenuated oral vaccine contains all 3 stereotypes مطعوم شلل الأطفال الفموي
☐ IPV: Killed vaccine, given IM. (Injectable / Inactivated) مطعوم شلل الأطفال المقتول

- Both are highly immunogenic and effective, seroconversion in 99-100% after 3 doses.

***NOTES:**

***IPV elicits higher immunity serum IgG levels. But OPV produces mucosal IgA immunity and limits virus replication in the GIT.**

***We still use OPV to achieve something called herd immunity (once the vaccine is introduced to the body orally, some of it is shed in the stool & this leads to immunize the individuals around in the same community), by this all the community will be immunized.**

## IPV/OPV Adverse Reactions

- OPV can cause VAPP ( vaccine associated paralytic polio), risk of having VAPP is much more after the first dose, so IPV is given in the first dose not OPV.
- IPV: has no side effects, but it is more expensive than OPV.

## IPV/OPV Contraindications

- OPV is contraindicated in immunocompromised patients.
- OPV is contraindicated in a patient who has another family member who is immunocompromised (because it's shed in stool).

# Combined DTaP Vaccine المطعوم الثلاثي البكتيري

## Diphtheria الخانوق

- Toxigenic strain of ***Corynebacterium Diphtheriae***, Gram positive, bacillus.
- Membranous nasopharyngitis or obstructive laryngotracheitis.
- Bull neck: swelling & cervical lymphadenitis.
- May results in upper airway obstruction, myocarditis, heart block, cranial or peripheral neuropathies.
- Case fatality rate 5-10%

## Tetanus الكزاز

- Caused by neurotoxin produced by ***Clostridium Tetani.***
- Anaerobic bacteria that contaminates the wound, spore-forming, obligate anaerobe.
- Neurological disease of trismus (lockjaw)and severe muscular spasm.
- **Wound management:**

| | Clean and Minor Wounds | | All Other Wounds | |
|---|---|---|---|---|
| **Previous tetanus-toxoid containing vaccine** | **Tetanus Vaccine** | **Tetanus Immune Globulin** | **Tetanus Vaccine** | **Tetanus Immune Globulin** |
| **Unknown or less than 3 doses** | YES | NO | YES | YES |
| **Greater than or equal to 3 doses** | YES if last dose ≥ 10 years ago | NO | YES if last dose ≥ 5 years ago | NO |

## Pertussis السعال الديكي

- Most severe in infants, may lead to sudden death.
- Complications: pneumonia, pulmonary hypertension, conjunctival hemorrhage, hernia, hypoxia, seizures (2%), encephalopathy (<0.5%), apnea, death.
- Case-fatality rate: 1% (age <2 mo),0.5% (age 2-11 mo).

- Maternal immunization in pregnancy decreased mortality and morbidity in infants.

## The Vaccine

- **Bacteria:**

1. Corynebacterium Diphtheria; Gram positive rod.
2. Clostridium tetani; Gram positive rod.
3. Bordetella Pertussis; Gram negative bacillus.

- **Type of vaccine:**

- [ ] D: toxoid
- [ ] T: toxoid
- [ ] P: Inactivated whole organism

***DTP has two types according to pertussis**:

- [ ] Inactivated whole organism = DTP
- [ ] Acellular DTaP, cell wall is removed from the bacteria to reduce side effects.

- **Doses:**

- [ ] DTP/DTaP: 6 doses given at day 61, day 91, day 121, 18 month, 6 years, 15 years.
- [ ] Td: given after age of 6 (clostridium tetani & low dose Diphtheria).

- **Route:**

- [ ] Given as Intramuscular injection in LUQ (left upper quadrant of thigh).

- **Effectiveness:**

- [ ] Tetanus vaccine is effective for 10 yrs, so you have to repeat it every 10 yrs.

## Side Effects and Contraindications

- **Mild Problems** (Common):

- [ ] Fever, Redness, swelling, Soreness (1 in 4).
- [ ] Fussiness (irritable, crying), Tiredness or poor appetite and Vomiting (1 in 50).
- [ ] These problems occur more often after the 4th and 5th doses of the DTP series than after earlier doses.
- [ ] Usually occurs within the first 48 hours of giving the vaccine.

- **Moderate Problems** (Uncommon):

- [ ] Seizures within the first 48 hours (1 in 14,000).
- [ ] Prolonged crying for 3 hours or more (1 in 1000).
- [ ] High fever (1 in 16,000).
- [ ] Hypotonic-hyporesponsive episode: collapse or shock like state.

- **Severe Problems** (Very Rare):

- [ ] Serious allergic reaction “anaphylaxis“ (1 in a million doses).
- [ ] Encephalopathy (long-term seizures, coma, or lowered consciousness, Permanent brain damage) within 7 days of vaccination & not attributable to another cause is an absolute **contraindication for further doses.**

***If a child presents with mild or moderate reaction, there is no contraindication to give pertussis but if it is severe >> pertussis is contraindicated (DT <6 YO, dT >6 YO)**

***Severe allergic reaction (anaphylaxis): will need desensitization to tetanus toxoid by allergist due to the importance of tetanus vaccination.**

***Cerebral palsy (CP) is a static not progressive disorder so it isn't a contraindication.**

## Precautions

- Guillain-Barre syndrome within 6 weeks of immunization.
- Moderate-severe illness, defer until recovers.
- Evolving neurological disorder, postpone to avoid the confusion regarding etiology and progression of the neurologic disorder.
- Fever > 40.5 during 48 hours of previous vaccine.
- Getting collapsed or shocked during 48 hours of previous vaccine.
- Seizure during 3 days of previous vaccine.
- Persistent inconsolable crying for more than 3 hours during the 1st 48 hours of pervious vaccine.

# Haemophilus Influenzae type b Vaccine (Hib) مطعوم السحايا

## Haemophilus Influenzae type b

- Causes pneumonia, **meningitis**, **epiglottitis**, bacteremia, septic arthritis, otitis media, cellulitis, etc.
- Transmitted by respiratory droplets or direct contact as it colonizes in the pharynx.
- Risk of infection in ages <5 years.
- Peak incidence of meningitis was 6 -18 months of age & of epiglottitis 2-4 years of age.
- Meningitis can be complicated by SNHL and long-term disabilities

## The Vaccine

- **Bacteria:**

☐ Haemophilus Influenzae.

***Protect against epiglottitis and meningitis.**

- Does Not cover non-typeable Haemophilus.
- Doesn't protect against otitis media ( which is caused by nontypeable haemophilus).
- **Type:**

☐ Conjugated capsular vaccine.

- **Doses:**

☐ 3 doses given at day 61, day 91, day 121.

- **Route:**

☐ Given as Intramuscular injection in the thigh.

- **Contraindication:**
- [ ] age less than 6 weeks.
- **Effectiveness:**
- [ ] Invasive disease does not confirm immunity; pts still require vaccines if their age is <5 yrs of age.

***Children over 5 years old usually don't need Hib.**

# Hepatitis B Vaccine (HBV) مطعوم التهاب الكبد نوع ب

## Hepatitis B

- Is a dsDNA virus of ***Hepadnaviridae*** family.
- In infected person the likelihood of developing **symptoms** in the acute infection **increases with age** (1% if <1 year, 5-15% if 1-5 yrs, 30-40% if >5 yrs)-yet the likelihood to become a **chronic carrier decreases with age** (90% if perinatal or <1year, 25-50% if 1-5 yrs, 5-10% if older child or adult).

***Chronic carrier status carries the risk of hepatocellular carcinoma. Thus it is very important to assess maternal hepatitis B status & vaccinate infants.**

## The Vaccine

- Hepatitis B virus ( DNA virus ).

** **Hepatitis A, C, D, E viruses are RNA viruses.**

** **There is NO hepatitis C vaccine.**

- **Type:**
- [ ] HBV vaccine is a Recombinant DNA surface antigen (Killed).
- **Effectiveness:**
- [ ] HBV vaccine is very effective & very safe.
- **Doses:**
- [ ] 3 doses are given at day 61, day 91, day 121 .
- **Route:**
- [ ] IM.
- **Adverse Effects:**
- [ ] Local pain at injection site (3-29%)
- [ ] Temperature >37.7 C (1-6%)
- **Special conditions:**
- [ ] Hepatitis B is sexually transmitted and can be transmitted by blood or vertically (from mother to fetus).
- [ ] Infant born to HBsAg positive mothers should receive the vaccine and HBIg within the 1st 12 hours of birth, one is given in the left leg & the other on the right because they work against each other.
- **How to differentiate between an infected and a vaccinated person?**

- [ ] Infected person has: antibodies against hepatitis B surface antigen (anti-HBsAg)+ antibodies against hepatitis B core antigen(anti-HbcAg).
- [ ] Vaccinated person has: anti - HBsAg ONLY, because HBV is made from the virus surface antigen by DNA-recombinant technology.

# Rotavirus Vaccine

## Rotavirus

- DsRNA virus.
- Causes gastroenteritis.
- Starts with vomiting, 24-48 hours later à watery diarrhea.
- ⅓ have fever.
- Illness for 3-7 days.
- Can be complicated by dehydration, electrolyte abnormalities and acidosis.

## The Vaccine

- Added to the national Jordanian program in March/2015.
- **Route:**

- [ ] Oral.

- **Type:**

- [ ] live attenuated vaccine.

*__RotaTeq® (RV5)__ is given in 3 doses at ages 2 months, 4 months, and 6 months. __Rotarix® (RV1)__ is given in 2 doses at ages 2 months and 4 months.

***In Jordan RotaTeq is used.**

- **Doses:**

- [ ] RotaTeq® (RV5) is given at 2nd, 3rd and 4th months in **Jordan** (with the HIB, HBC, DTP).
- [ ] NO catch-up if behind (no doses after the age of 8 months).
- [ ] Do NOT initiate vaccination if age is ≥15 weeks and 0 days.
- [ ] Do NOT repeat the vaccine if the patient spits it out.
- [ ] Should still vaccinate even if baby did have rotavirus gastroenteritis.
- [ ] ALL doses should be given BEFORE the age of 8 months.

- **Contraindications:**

- [ ] Severe combined immunodeficiency.
- [ ] History of intussusception.

***It's okay to give for household contact of immunocompromised person or pregnant woman (but follow a good hand hygiene).**

***AVOID it if the mother received biologics (Possible transplacental transfer).**

- **Effectiveness:**

- [ ] Safe and highly effective.

# Mumps, Measles, Rubella Vaccine (MMR)

## Measles الحصبة

- Enveloped RNA virus of the genus ***Morbillivirus*** in the ***Paramyxoviridae*** family.
- Illness is characterized by fever, cough, coryza, conjunctivitis, followed by maculopapular rash (spreads from face down).
- Koplik spots in prodromal phase
- **Complications:**

- [ ] otitis media, bronchopneumonia, croup, diarrhea, rarely acute encephalitis with possible permanent brain damage (1:1000).
- [ ] Case fatality rate increased if age <5yrs, pregnancy  immunocompromised patients.
- [ ] Subacute sclerosing panencephalitis(SSPE):  in 4-11:100,000, occurs 7-11 years after the initial infection, which is a degenerative CNS disease.

## Mumps أبو دغيم

- An RNA virus of the genus ***Rubulavirus***  in the family ***Paramyxoviridae.***
- Systemic disease with swelling of salivary glands-usually the parotid.
- ⅓ of the cases are asymptomatic/subclinical or mimic URI.
- Might be complicated by viral meningitis, orchitis(after puberty), pancreatitis, SNHL and other complications.

## Rubella الحصبة الألمانية

- RNA virus, genus ***Rubivirus*** in the ***Togaviridae*** family.
- Clinical disease is mild.
- Maculopapular rash (face then generalized in 24 hours and lasts for 3 days), lymphadenopathy and slight fever).
- Transient polyarthralgia/polyarthritis (more common in adolescent females).
- Rarely thrombocytopenia and encephalitis.

- ***If infection occurs in pregnancy, then the baby will have congenital rubella syndrome:**

1. **PDA**
2. **Microcephaly**
3. **Eye abnormalities: Cataract/Glaucoma/Nystagmus/Iris dysplasia… etc**
4. **Purpura/Petechiae**

## The Vaccine

- **Viruses:**

1. Measles >> الحصبة
2. Mumps >> النكاف \ أبو دغيم \ أبو كعب
3. Rubella >> الحصبة الألمانية

- **Types:**
- [ ] Live attenuated vaccine.
- **Doses:**
- [ ] **Measles** alone is given at 9 months & MMR at 18 months.
- **Route:**
- [ ] Given as subcutaneous injection
- **Side effect:**
- [ ] mild rash, swelling of glands in the cheeks and neck after 9 - 12 days of the vaccine (occupation period for measles).
- **Precaution:**
- [ ] Recent blood transfusion within less than 11 months.
- **Contraindications:**
- [ ] Pregnant women or women intending to become pregnant within the next 28 days.
- [ ] Contraindications of live – virus vaccines.
- [ ] Person with anaphylactic egg or neomycin allergy.
- **Effectiveness:**
- [ ] 95% effective after 1 dose, and 98%effective after 2 doses.

*** Children with minor acute illnesses (including febrile illnesses), non anaphylactic egg allergy, or a history of tuberculosis should be immunized.**

*** MMR are not contraindicated in household contacts of immunocompromised children.**

# Other Added Vaccines

## Pneumococcal Vaccine

- Has two types: polysaccharide and conjugated.

| Polysaccharide | Conjugated |
|---|---|
| 23 Valent vaccine | 13 Valent vaccine |
| Usually 2 doses are given | Usually 4 doses are given |
| Helps in preventing serious pneumococcal diseases: pneumonia, bacteremia, meningitis | Helps in preventing serious pneumococcal diseases: pneumonia, bacteremia, meningitis, also prevents some cases of otitis media. |
| Given for anyone > 2 years with any of the following conditions: Heart or lung disease, Sickle cell disease, DM, lymphoma, Leukemia, Kidney failure, asplenia, nephrotic syndrome, HIV or AIDs. | Can be given for children younger than 2 years. PCV13 is routinely given to children at 2,4, 6, and 12–15 months of age. It is also recommended for children and adults from 2 to 64 years of age with certain health |

| | |
|---|---|
| | conditions, and for all adults > 65 years of age. |
| Has minor side effects | Has minor side effects |

## Varicella Vaccine

- Live attenuated.
- Can prevent chickenpox , and if the patient got chickenpox after he took the vaccine; it will be mild, fewer spots, less likely to have fever and faster recovery.
- **Doses:**

☐ First dose: between 12th-15th month.
☐ Second dose: between 4th-6th year old age.

- **Contraindications:**

☐ ( same as MMR )

*Not contraindicated in household contacts of immunocompromised children.

- **Precaution:**

☐ Recent blood transfusion or blood product (less than 11 months).

## Inactivated Influenza Virus Vaccine

- Killed.
- Given IM, the recommended site of vaccination is the anterolateral aspect of the thigh for younger children and the deltoid for older children.
- Contraindicated in egg allergy.
- Annual influenza vaccination is indicated for all children older than 6 months of age who have a chronic health condition that increases their risk of complications from influenza infection (asthma, DM, HIV, CF, sickle cell disease & cardiac condition).
- Children younger than 6 months should not be immunized.
- Two doses are recommended for children younger than 9 years who are receiving influenza vaccine for the first time; subsequent seasons require single doses. Older children receiving vaccine for the first time require only a single dose.
- Strains that were pathogenic the year before are included in the vaccine.
- Effectiveness up to 95%
- 2019-2020 vaccine is quadrivalent (has 2 influenza A and 2 influenza B strains)

## Live Influenza Virus Vaccine

- Administered intranasally.
- Contraindicated in immunocompromised patients.
- Given only to healthy people, 2-49 yrs of age who are not pregnant and do not have certain health conditions.
- **Not available in Jordan.**

## Meningococcal Vaccine

- Protect against Neisseria meningitides.
- **(MCV4)** >> a tetravalent meningococcal polysaccharide-protein conjugate vaccine.
- Given IM, single dose.
- Indicated for use between 2–55 years.
- This vaccine is protecting against meningococcal serogroups A, C, Y, and W-135
- Currently is recommended for routine use in young adolescents (aged 11–12 years), those entering high school (at approximately 15 years of age), and college freshmen living in dormitories, as well as other groups at increased risk of meningococcal disease.
- MCV4 vaccination is contraindicated in someone with a prior history of Guillain-Barre syndrome.

- **(MPSV4)** >> a tetravalent meningococcal pure polysaccharide vaccine.
- Given SC, single dose.
- Protect against the same four strains of meningococcus, and both are safe and immunogenic.
- Indicated for use in persons 2 years and older.

## Hepatitis A Vaccine (HAV)

- Killed / Inactivated vaccine.
- **Route:**

☐ Administered intramuscularly in two doses separated by 6–12 months.

- **HepA vaccination is indicated for the following groups:**

1. Travelers to countries with high rates of hepatitis A.
2. Children with chronic hepatitis B or hepatitis C infections or other chronic liver disease.
3. Children with clotting factor disorders.
4. Adolescent and adult males who have sex with men.
5. Persons with an occupational exposure to hepatitis A.
6. Illegal drug users.

- Very safe.
- **Special conditions:**

☐ Post-exposure prophylaxis of persons who recently have been exposed to hepatitis A and who previously have not received HepA vaccine should be administered Intramuscular immunoglobulin, as soon as possible but not more than 2 weeks after the last exposure.

## General Notes

- If HBV is missed, it can be given at any time.
- If Measles is missed it can be given at 12 month.
- Any child who is diagnosed with Cystic Fibrosis should take additional vaccine:

1. Pneumococcal conjugated vaccine 2 to 4 doses before 2 years of age at 2nd, 4th, 6th, 18th months.

2. Influenza after age of one year.

- **Common Questions:**

☐ My kid has tonsillitis (mild infection) and he has to get vaccinated, should I wait till the baby gets better?

✓ No, in mild illnesses we give the vaccine.

☐ My kid is diagnosed with sickle cell anemia, what added vaccines should he receive?

✓ Pneumococcal (polysaccharide) > 2years.

✓ Hib.

✓ Influenza virus .

✓ HBV .

☐ My kid is diagnosed with G6PD anemia, what added vaccines should he receive?

✓ Hepatitis A , Hepatitis B