Epidemiology of Measles & Rubella

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REFERENCE

- **Parks social and preventive medicine 27th edition.**

OBJECTIVES

- Understand the key epidemiological characteristics of measles and rubella, including their respective modes of transmission, incubation periods, and communicability.
- Recognize the public health significance of measles and rubella, particularly the severe consequences of congenital rubella syndrome and measles complications like pneumonia and encephalitis.
- Appreciate the importance of vaccination in the prevention and control of these diseases

MEASLES

- An acute highly infectious disease of childhood
- Caused by a specific virus of the group myxoviruses.
- It is clinically characterized by:

fever and catarrhal symptoms of the upper respiratory tract (coryza, cough), followed by a typical rash.

Problem of measles

- Measles is endemic virtually in all parts of the world.
- It tends to occur in epidemics when the proportion of susceptible children reaches about 40%.
- When the disease is introduced into a virgin community more than 90% of that community will be infected.
- While measles is now rare in industrialized countries, it remains a common illness in many developing countries.
- The primary reason for continuing high childhood measles mortality and morbidity is the failure to deliver at least one dose of measles vaccine to all infants

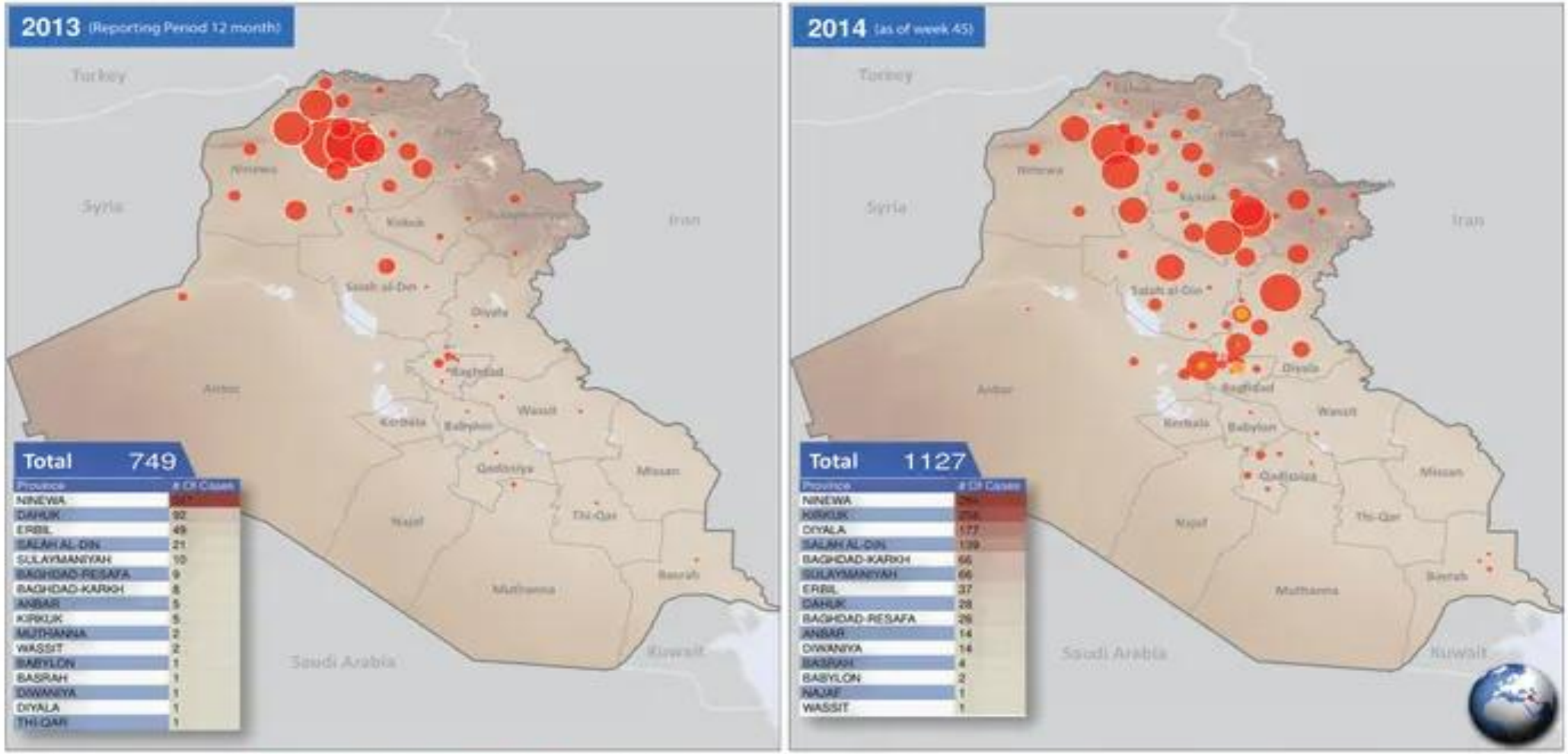
- Measles is associated with high morbidity and mortality in developing countries.
- Measles occurs only in humans.
- There is no animal reservoir of infection.

IRAQ MEASLES OUTBREAK

- In 2008–2009, Iraq experienced a major measles outbreak, with 30,321 reported cases in 2009 alone .
- During the outbreak, 11 of the 18 governorates reported their highest incidence of the time-series

World Health Organization
Eastern Mediterranean

IRAQ: Confirmed Measles Cases by Districts
(for 2013 and week 45 of 2014)



Legend
# of Confirmed Measles Cases
100
50
10
1
Cases registered in week 45
1
2
3 - 4

1-The total number of measles cases in 2013 was 749, while in 2014 (up to week 45) the number of cases reached 1127, 10 new cases were registered in week 45. 2- In 2013 the majority of the cases were distributed over Ninewa and Dahuk Governorates. In 2014 the cases are distributed over Ninewa, Salahaddin, Kirkuk, Diyala. 3- In 2014 the number of cases decreased by 50% in Ninewa and 80% in Dahuk compared with 2013, while the number of cases in Kirkuk increased from 5 to 258 Measles cases, and in Diyala the number of cases went from 1 to 178 Measles cases.

Further information:
World Health Organization
Iraq Country Office
Hussains@who.int
Data Source:
Ministry of Health/ WHO
District boundaries
Health district boundaries, are not always match the administrative boundaries.

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Creation Date: 9 Nov 2014

Recent outbreak(23-24)

- Iraq has been dealing with a significant measles outbreak, with over 27,000 cases recorded between late 2023 and early 2024.
- The outbreak is primarily affecting unvaccinated children and is attributed to factors like decreased vaccination rates during the COVID-19 pandemic, with some regions seeing coverage drop from over 80% to about 63%.

USA: November 7, 2024

- A total of 277 measles cases were reported by 32 states: Arizona, California, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New Mexico, New York City, New York State, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Vermont, Virginia, Washington, Wisconsin, and West Virginia.

Agent factor

- Measles is caused by an RNA paramyxovirus.
- So far as is known, there is only one serotype.
- The virus cannot survive outside the human body for any length of time, but retains infectivity when stored at sub-zero temperature.
- The virus has been grown in cell cultures.

SOURCE OF INFECTION:

- The only source of infection is a case of measles.
- Carriers are not known to occur.
- There is some evidence to suggest that subclinical measles occurs more often than previously thought.

INFECTIVE MATERIAL

- Secretions of the nose, throat and respiratory tract of a case of measles during the prodromal period and the early stages of the rash.

COMMUNICABILITY

- Measles is highly infectious during the prodromal period and at the time of eruption.
- Communicability declines rapidly after the appearance of the rash.
- The period of communicability is approximately 4 days before and 4 days after the appearance of the rash.
- Isolation of the patient for a week from the onset of rash more than covers the period of communicability

SECOND ATTACKS

- There is only one antigenic type of measles virus.
- Infection confers life long immunity.
- Most so-called second attacks represent errors in diagnosis either in initial or second illness

Host factors

- **AGE :**
- Affects virtually everyone in infancy or childhood between 6 months and 3 years of age in developing countries where environmental conditions are generally poor.
- Older children usually over 5 years in developed countries .
- Following the use of measles vaccine, the disease is now seen in somewhat older age groups .
- **SEX** : Incidence equal.

- **IMMUNITY** :

- One attack of measles generally confers life-long immunity.
- Infants are protected by maternal antibodies up to 6 months of age; in some, maternal immunity may persist beyond 9 months.
- Immunity after vaccination is quite solid and long-lasting.

- **NUTRITION** :
- Measles tends to be very severe in the malnourished child, carrying a mortality up to 400 times higher than in well-nourished children having measles.
- This may possibly be related to poor cell-mediated immunity response, secondary to malnutrition.
- Additionally, severely malnourished children have been shown to excrete measles virus for longer periods than better nourished children indicating prolonged risk to themselves, and of intensity of spread to others .
- Even in a healthy child, an attack of severe measles may be followed by weight loss, precipitating the child into malnutrition.

Environmental factors

- Given a chance, the virus can spread in any season.
- In tropical zones, most cases of measles occur during the dry season.
- In temperate climates, measles is a winter disease, probably because people crowd together indoors
- Population density and movement do affect epidemicity .
- In general, the less favorable the prevailing socio-economic conditions, the lower the average age at which children are attacked.

Transmission

- Transmission occurs directly from person to person mainly by droplet infection and droplet nuclei, from 4 days before onset of rash until 4 days thereafter.
- The portal of entry is the respiratory tract.
- Infection through conjunctiva is also considered likely as the virus instilled into the conjunctiva can cause infection.
- Recipients of measles vaccine are not contagious to others

Incubation period

- Incubation period is commonly 10 days from exposure to onset of fever, and 14 days to appearance of rash.
- When measles infection is artificially induced bypassing the respiratory tract (as with injection of live measles vaccine), the incubation period is somewhat shortened, averaging 7 days.

Clinical features

- There are three stages in the natural history of measles, viz.:
- the prodromal or pre-eruptive stage,
- eruptive stage and
- post-measles stage.

1. PRODROMAL STAGE

- It begins 10 days after infection, and lasts until day 14.
- It is characterized by fever, coryza with sneezing and nasal discharge, cough, redness of the eyes, lacrimation and often photophobia.
- There may be vomiting or diarrhoea.
- A day or two before the appearance of the rash Koplik' s spots like table salt crystals appear on the buccal mucosa opposite the first and second lower molars.
- They are small, bluish-white spots on a red base, smaller than the head of a pin , Their presence is pathognomonic of measles.

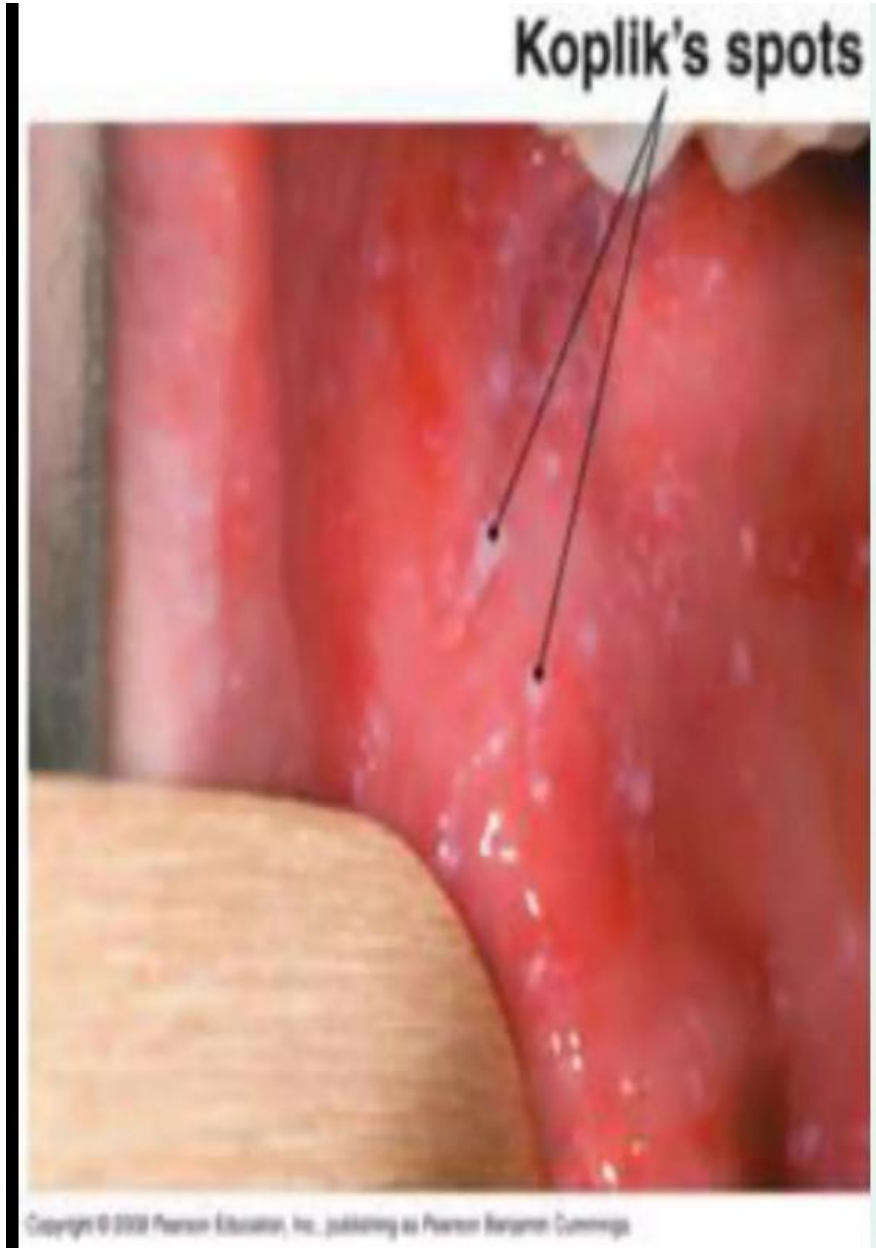


Fig 1. **Maculopapular rash**

2. ERUPTIVE PHASE

- This phase is characterized by a typical, dusky-red, macular or maculo-papular rash which begins behind the ears and spreads rapidly in a few hours over the face and neck, and extends down the body taking 2 to 3 days to progress to the lower extremities.
- The rash may remain discrete, but often it becomes confluent and blotchy.
- In the absence of complications, the lesions and fever disappear in another 3 or 4 days signaling the end of the disease.
- The rash fades in the same order of appearance leaving a brownish discoloration which may persist for 2 months or more.
- During the prodromal phase (2-4 days) and the first 2-5 days of rash, virus is present in tears, nasal and throat secretions, urine and blood.

- Just as the maculo-papular rash appears, the circulating antibodies become detectable, the viraemia disappears and the fever falls.
- The rash develops as a result of interaction of immune T cells with virus infected cells in the small blood vessels.
- In patients with defective cell-mediated immunity, no rash develops .
- Diagnosis of measles is based on the typical rash and Koplik's spots seen in oral mucosa.
- The diagnosis would normally be incorrect in any febrile exanthem in which red eyes and cough are absent.
- In developed countries, where measles is uncommon, specific IgM antibodies are being used for diagnosis.

3. POST -MEASLES STAGE

- The child will have lost weight and will remain weak for a number of days.
- There may be failure to recover and a gradual deterioration into chronic illness due to increased susceptibility to other bacterial and viral infections, nutritional and metabolic effects and the tissue destructive effects of the virus.
- There may be growth retardation and diarrhoea, cancrum oris, pyogenic infections, candidosis, reactivation of pulmonary tuberculosis etc.

Risk of complications

- 1. Under 5 years.
- 2. Overcrowding.
- 3. Malnutrition(specially vitamin A deficiency).
- 4. Decreased immunity(AIDS).

Complications

- The most common complications are:

1.measles-associated diarrhoea,

2.Otitis media occurs in about 5-15 per cent of cases.

3. Pnumonia is the most common life-threatening complication.

This occurs in less than 10 per cent of cases in developed countries and 20-80 per cent cases in developing countries.

Pulmonary complications account for more than 90 per cent of measles-related deaths.

Pneumonia develops in 3-15 per cent of adults with measles, but most cases are due to the virus itself rather than bacteria, and fatalities are rare

- 4. neurological complications:
- The more serious are the neurological complications which include febrile convulsions, encephalitis and subacute sclerosing pan-encephalitis (SSPE).

- Subacute sclerosing pan-encephalitis is a rare complication which develops many years after the initial measles infection.
- It is characterized by progressive mental deterioration leading to paralysis, involuntary movements, muscle rigidity and coma, probably due to persistence of the virus in the brain.
- The frequency of SSPE is about 1:300,000 cases of natural measles.
- It is usually fatal within 1-3 years after onset.

- Encephalitis is another serious complication.
- It occurs in about 1 in 1000 cases.
- The cause is unknown.
- Measles vaccination definitely constitutes a protection against the neurological and other complications by preventing natural measles from occurring

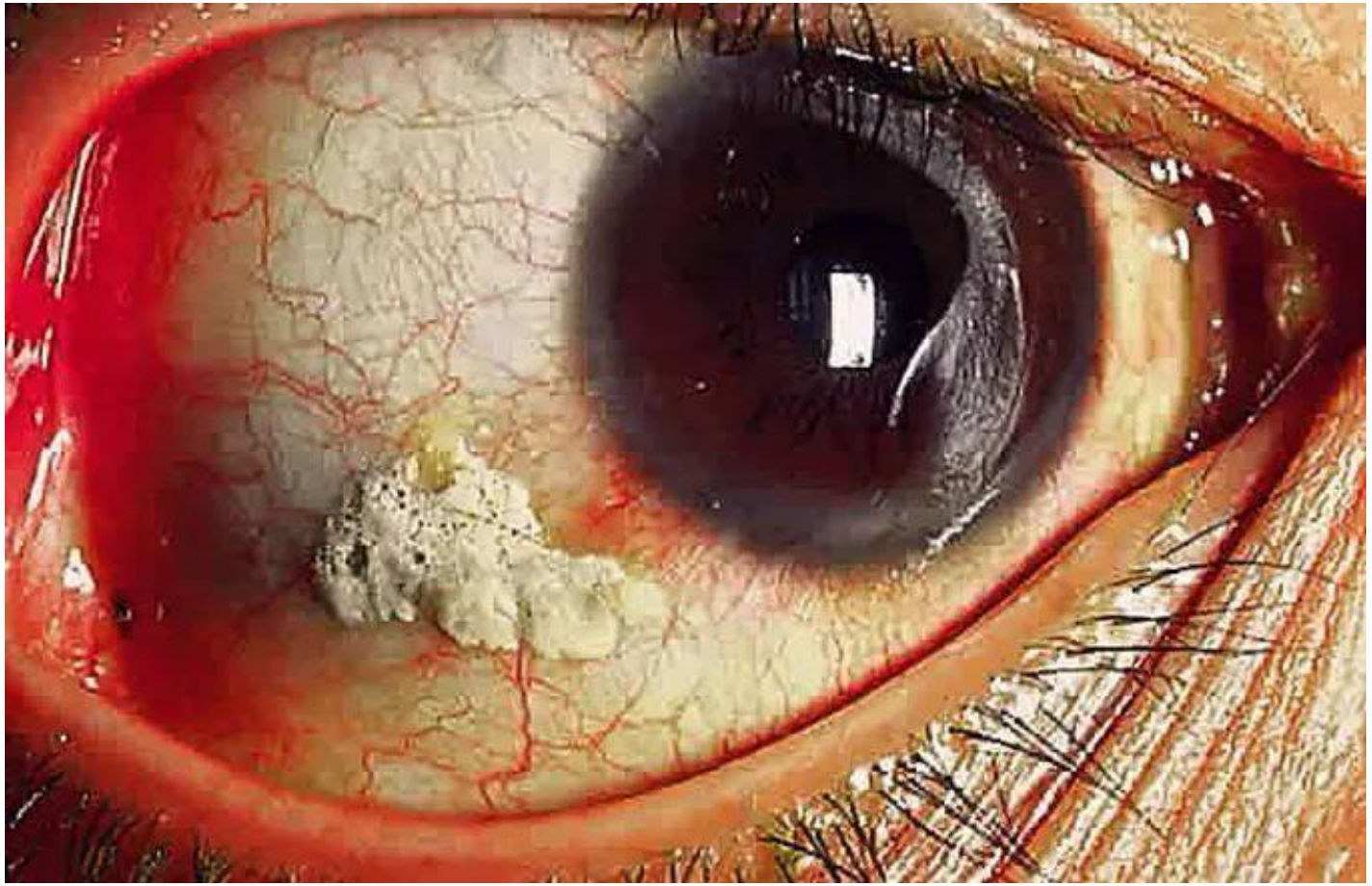
- Measles during pregnancy: is not known to cause congenital abnormalities of the foetus.
- However, it is associated with spontaneous abortion and premature delivery.
- Measles in the offspring of mothers with measles ranges from mild to severe; therefore, it is recommended that infants born to such mothers be passively immunized with immunoglobulin at birth

MEASLES AND VITAMIN A

- All cases of severe measles, and all cases of measles in areas with high case-fatality rates should be treated with vitamin A, as many children develop acute deficiency of vitamin A, which may lead to keratomalacia and blindness from corneal scarring.
- A high dose of vitamin A is given immediately on diagnosis and repeated the next day.

- The recommended age-specific daily doses are
- for infants aged <6 months50,000 IU
- 6-11 monts 100,000IU
- 12 MONTHS 200,000IU
- 3RD DOSE 4-6 MONTHS FOR VIT. DEFECIENCY clinical signs(Bitots spots).

Bitot’s spot(reversible eye disorder characterized by superficial foamy patches.



Measles and chickenpox

- It has been noted that sometimes measles and chickenpox may occur together and one most remarkable finding in these cases of double infection is that the first infection may diminish the severity of the rash of the second infection

Prevention of measles

- The following guidelines are important in combating measles:
- A. achieving an immunization rate of over 95 per cent,
- B. on-going immunization against measles through successive generations of children.

Measles vaccination

- Measles is best prevented by active immunization.
- (1) VACCINE : Only live attenuated vaccines are recommended for use; they are both safe and effective
- (SUBCUTANEOUS,INTRAMUSCULAR) equally effective.
- (2) AGE : The principal problem of measles immunization is timing; immunization before the age of 9 months runs the risk of the vaccine being rendered ineffective by the natural antibodies acquired through the mother.
- Immunization later than 9 months means that a significant proportion of children will contract measles in the interval between wearing off natural protection, and the introduction of the vaccine.
- The most effective compromise is immunization as close to the age of 9 months as possible The WHO Expanded Programme on Immunization recommends immunization at 9 months age.

IMMUNE RESPONSES

- Measles vaccine induces both humoral and cellular immune responses comparable to those following natural infection, although antibody titers are usually lower.
- Also, lower average concentrations of maternal antibodies are found in infants born to vaccinated mothers when compared with naturally infected mothers.
- Following vaccination, transient measles-specific imrnunoglobulin (lg) M antibodies appear in the blood and IgA antibodies appear in mucosa secretions; IgG antibodies persist in the blood for years.
- Vaccination also induces measles virus-specific CD4+ and CDS+ T lymphocytes

REACTIONS

- When injected into the body, the attenuated virus multiplies and induces a mild "measles" illness (fever and rash) 5 to IO days after immunization, but in reduced frequency and severity.
- This may occur in 15 to 20 per cent of vaccinees.
- The fever may last for 1-2 days and the rash for 1-3 days.
- There is no cause for alarm.
- The vaccines now given rarely cause severe reaction .
- There is no spread of the virus from the vaccinees to contacts

IMMUNITY

- The vaccine has convincingly demonstrated to provide immunity to even severely malnourished children.
- Immunity develops 11 to 12 days after vaccination and appears to be of long duration, probably for life.
- One dose of the vaccine given at 11-12 months of age appears to give 99 per cent protection.
- Infants vaccinated at the age of 9 months show seroconversion of about 90 per 'cent.

CONTACTS :

- Susceptible contacts over the age of 9-12 months may be protected against measles with measles vaccine, provided that this is given within 3 days of exposure.
- This is because, the incubation period of measles induced by the vaccine is about 7 days, compared with IO days for the naturally acquired measles.

CONTRAINDICATIONS for measles vaccine

- Mild concurrent infections are not considered a contraindication to vaccination, but it should be avoided if the patient has a high fever or other signs of serious disease.
- Measles vaccine alone, or in combination with other vaccines, should also be avoided by pregnant women.
- Being in the early stages of HIV infection is not a contraindication to measles vaccination.
- measles vaccine is contraindicated in persons who are severely immunocompromised.

ADVERSE EFFECTS OF VACCINE

- Toxic shock syndrome (TSS) occurs . when measles vaccine is contaminated or the same vial is used for more than one session on the same day or next day(usually more than 4 hours after opening the vial).
- Reflects poor immunization services.
- Characterized by:
- severe watery diarrhea , vomiting and fever.
- Reported within few hours of measles vaccine.
- Cluster of infants vaccinated by the same vial.
- High case fatality within 48 hours.

- Second dose of measles vaccine may be added to the routine immunization schedule in countries that have achieved 80% coverage of the first dose of the vaccine at the national level for 3 .consecutive years, as determined by the most accurate means available.
- COMBINED VACCINE : Measles vaccine can be combined with other live attenuated vaccines such as mumps, and rubella vaccines (MMR vaccine), measles, mumps, rubella and varicella (MMRV), and measles and rubella (MR), and such combinations are also highly effective.

2. immunoglobulin

- Measles may be prevented by administration of immunoglobulin (human) early in the incubation period.
- The dose recommended by WHO is 0.25 ml per kg of body weight .
- It should be given within 3-4 days of exposure.
- The person passively immunized should be given live measles vaccine 8-12 weeks later.
- The need for immunoglobulin is now much reduced because of the availability of an effective live attenuated vaccine.

Eradication of measles

- It is believed that measles, like smallpox, is amenable to eradication.
- Measles immunization has in its favor the fact that only one dose is needed, and that a measles vaccine has now been developed which is more heat stable.
- It requires
- (a) achieving an immunization coverage of at least 96% of children under one year of age, and that
- (b) the cumulation in the immunity gap be prevented.

Outbreak control measures

- The following control measures have been recommended :
- (a) isolation for 7 days after onset of rash,
- (b) immunization of contacts within 2 days of exposure (if vaccine is contraindicated, immunoglobulin should be given within 3-4 days of exposure), and
- (c) prompt immunization at the beginning of an epidemic is essential to limit the spread.

- The age can be lowered to 6 months if there is measles outbreak in the community.
- For infants immunized between 6 months and 9 months of age, a second dose should be administered as soon as possible after the child reaches the age of 9 months provided that at least 4 weeks have elapsed since the last dose.
- In countries where the incidence of measles has declined, the age of immunization is being raised to 12 months in order to avoid the blocking effect of persistent transplacentally acquired antibody

Epidemiology of Rubella

Introduction

- **Rubella**, commonly known as **German measles,** is a disease caused by Rubella virus. The name is derived from the Latin, meaning ***little red*.**
- Rubella is also known as German measles because the disease was first described by German physicians, Friedrich Hoffmann, in the mid-eighteenth century.

Rubella or German measles

- is an acute childhood infection, usually mild, of short duration (approximately 3 days)
- and accompanied by low-grade fever,
- lymphadenopathy and a maculopapular rash.
- Infection in early pregnancy may result in serious congenital defects, including death of the fetus.
- The disease is worldwide in distribution and tends to occur in epidemics, in non-immunized populations, every 6 to 8 years

History

- Rubella was considered a mild and benign disease until 1941 when Norman Gregg, an ophthalmologist reported an epidemic of congenital cataracts associated with other congenital defects in children born to mothers who had rubella during their pregnancies.
- This discovery changed the concept that rubella is not merely a benign disease of childhood but also one with teratogenic potential.
- In 1962, the virus was isolated; in 1967, an attenuated vaccine was developed.

Agent factors

- (a) AGENT :
- Rubella is caused by an RNA virus of the togavirus family.
- Only one antigenic type of the virus seems to exist.
- The virus has been recovered from the nasopharynx, throat, blood, CSF and urine.
- It can be propagated in cell culture.

SOURCE OF INFECTION

- Clinical or subclinical cases of rubella.
- A large number of rubella infections are, in fact, subclinical.
- This represents one of the major differences between measles and rubella.
- Infants born with congenital rubella may shed the virus for many months.
- The vaccine virus is not communicable.

PERIOD OF COMMUNICABILITY:

- Rubella is much less communicable than measles, probably because of the absence of coughing in rubella.
- It is difficult to state the exact period of infectivity.
- It probably extends from a week before symptoms to about a week after rash appears.
- Infectivity is greatest when the rash is erupting

Host factors

- (a) AGE:
- Mainly a disease of childhood particularly in the age group 3 to 10 years.
- Persons older than 15 years now account for over 70 per cent cases in developed countries this is similar to the changing epidemiological pattern with measles, following widespread immunization campaigns against the disease.

IMMUNITY

- One attack results in life-long immunity;
- second attacks are rare.
- Infants of immune mothers are protected for 4 to 6 months.
- It is estimated that 10 to 40 per cent of the population could reach adulthood without experiencing rubella infection in the absence of immunization .
- Thus many women of child-bearing age may remain rubella-susceptible.

Environmental factors

- Disease usually occurs in a seasonal pattern i.e. in temperate zones during the late winter and spring, with epidemics every 4-9 years.

Transmission

- The virus is transmitted directly from person to person by droplets from nose and throat, and droplet nuclei (aerosols), from one week before onset of rash to one week after it has faded.
- The portal of entry is via the respiratory route.
- The virus is maintained in human population by chain transmission.
- The virus can cross the placenta (vertical transmission} and infect the fetus in utero, leading to congenital rubella in the newborn.

- Incubation period 2 to 3 weeks; average 18 days.

Clinical features

- A large percentage of infections (50 to 65 per cent) are asymptomatic
- In a typical case, the clinical features comprise the following:
- (a) PRODROMAL : The prodromal symptoms (coryza, sore throat, low-grade fever) herald the onset of viraemia.
- They are generally mild and insignificant, and less frequent in children.

- (b} LYMPHADENOPATHY: In susceptible individuals, the enlargement of the post auricular and posterior cervical lymph nodes appears as early as 7 days before the appearance of the rash.
- This, however, is not pathognomonic since cases of clinical rubella without enlargement of lymph nodes have been documented.
- The glands may be found enlarged for 10 to 14 days after the rash.

Rash

- It appears first on the face, usually within 24 hours of the onset of prodromal symptoms.
- It is a minute, discrete, pinkish, macular rash and not confluent as the rash of measles.
- Conjunctivitis may occur.

Rash (cont.)

- The rash spreads rapidly to the trunk and extremities, by which time it is often no longer apparent on the face.
- The rash spreads much faster and clears more rapidly than the rash of measles.
- It disappears altogether by the third day.
- The rash is an inconstant feature of the disease; it is absent in rash subclinical cases.
- The incidence of rubella infection without rash may be up to 25%.

COMPLICATIONS :

- In rare instances arthralgia may occur in several joints in adults, especially young women.
- Encephalitis is very rare.
- Thrombocytopenic purpura has also been observed as a complication.
- And the congenital malformations.

Diagnosis

- Because of its mildness and variability of symptoms, the disease can go unrecognized unless it is an epidemic.
- A definitive diagnosis of rubella is possible only through virus isolation :
- Throat swabs should be cultured for virus isolation; it takes longer than serological diagnosis.
- Serology: ELISA tests to detect specific lg M.
- Detection of IgG is evidence of immunity because there is only one serotype of rubella virus.
- To accurately confirm a recent rubella infection, either a rise in antibody titer must be demonstrated between two serum samples taken at least 10 days apart or rubella-specific lgM must be detected in a single specimen.
- It is critically important in a pregnant woman

CONGENITAL RUBELLA

- Congenital rubella syndrome (CRS) refers to infants born with defects secondary to intrauterine infection or who manifest symptoms or signs of intrauterine infection sometime after birth.
- Congenital infection is considered to have occurred if the infant has IgM rubella antibodies shortly after birth (as IgM antibodies do not cross the placenta, their presence indicate that they must have been synthesized by the infant in utero) or if lgG antibodies persist for more than 6 months, by which time maternally derived antibodies would have disappeared.
- Intrauterine infection with rubella is associated with chronic persistence of the virus in the newborn.

Virus duration in infant body

- At birth, virus is easily detectable in pharyngeal secretions, multiple organs, cerebrospinal fluid, urine, and rectal swabs.
- Viral excretion may last for 12-18 months after birth, but the level of shedding gradually decreases with age.

Pathological effect on fetus

- Rubella infection inhibits cell division, and this is probably the reason for congenital malformations and low birth weight.
- The classic triad of congenital defects are deafness, cardiac malformations and cataracts.
- Other resulting defects microcephalus, include cerebral palsy,glaucoma, retinopathy, intrauterine growth retardation, hepato-splenomegaly, mental and motor retardation, radiolucency of long bones.
- These defects occurring singly or in combination have become known as "congenital rubella syndrome".

- Congenital rubella is a chronic infection while acquired rubella is an acute infection.
- The fetus remains infected throughout gestation and for months and sometimes years postnatally.
- The gestational age at which maternal infection occurs is a major determinant for the extent of fetal infection as well as the effects on the fetus.

Gestational age and timing of infection

- The first trimester of pregnancy is the most disastrous time for the fetus as the organs are developing.
- Infection during 1st trimester results in abnormalities in the infant in about 85%of cases.
- whereas detectable defects are found in about 16% of infants, who acquired infection during the second trimester.
- Birth defects are uncommon if maternal infection occurs after 20 weeks of gestation.
- Inapparent maternal infections can produce these anomalies as well.
- It can result in fetal death and spontaneous abortion

- Infants who survives neonatal period may suffer from:
- 1. Auditory , visual impairment.
- 2. Autism.
- 3. Developmental delay.

Prevention

- Active immunization against rubella is now possible with live attenuated vaccines.
- The goal of rubella immunization is the prevention of rubella infection during a future pregnancy.

Rubella vaccine

- Rubella vaccine induces higher antibody titres and produces an immune response more closely paralleling natural infection.
- There is evidence that it largely prevents subclinical superinfection with wild virus.
- Is administered in a single dose of 0.5 ml subcutaneously.
- It may provoke mild reactions in some subjects such as malaise, fever, mild rash and transient arthralgia, but no serious disability.
- Seroconversion occurs in more than 95 per cent vaccinees.

Rubella vaccine (cont.)

- Vaccine-induced immunity persists in most vaccinees for at least 14 to 16 years and probably is lifelong .
- There is no evidence in favor of the administration of second dose unless first vaccinated below the age of 12 months .
- Infants under one year should not be vaccinated due to possible interference from persisting rubella antibody.
- Pregnancy is considered a contraindication to rubella immunization.
- The recipients of the vaccine should be advised not to become pregnant over the next 3 months.
- Rubella vaccine is also available as combined measles, mumps and rubella (MMR) vaccine. It is equally effective .