Polio: A Detailed Essay for Microbiology Exam

1. Causative Organism

Poliovirus: A member of the genus Enterovirus and family Picornaviridae. It is a single-stranded RNA virus with three serotypes:

Type 1: Most commonly associated with epidemics.

Type 2: Eradicated globally in 1999.

Type 3: Less common, but still in circulation.

2. Mode of Transmission

Fecal-oral route: This is the primary mode of transmission, typically through ingestion of water or food contaminated with feces of an infected individual.

Direct person-to-person contact: Occurs when an infected person's fecal matter or respiratory secretions come into contact with a susceptible host.

Respiratory droplets: Transmission through droplets can occur, but it is rare compared to fecal-oral transmission, especially during close contact with an infected individual.

3. Pathogenesis

Initial infection and replication:

The virus enters the body through the mouth and initially replicates in the oropharyngeal and gastrointestinal mucosa.

The virus then multiplies in the lymphoid tissues, such as the tonsils, Peyer's patches (in the small intestine), and regional lymph nodes.

Primary viremia:

After replication, the virus enters the bloodstream (primary viremia). Most cases are cleared at this stage by the immune system, resulting in asymptomatic infection.

Secondary viremia:

In a small percentage of cases, the virus persists in the bloodstream and disseminates to other organs, particularly targeting the central nervous system (CNS).

CNS involvement:

Once in the CNS, the virus preferentially invades and destroys motor neurons in the anterior horn of the spinal cord, brainstem, or motor cortex. This destruction of motor neurons results in flaccid paralysis.

4. Clinical Features/Symptoms

Polio can manifest in several distinct clinical forms:

Asymptomatic infection (90-95% of cases):

Most individuals exposed to poliovirus remain asymptomatic due to effective clearance of the virus by the immune system during the viremia phase.

Abortive poliomyelitis (Minor illness; ~5% of cases):

Fever, sore throat, headache, vomiting, fatigue, and malaise.

Non-specific symptoms of viral infection, which resolve in a few days without complications.

Non-paralytic poliomyelitis (Aseptic meningitis; ~1-2% of cases):

In addition to the symptoms seen in abortive poliomyelitis, there may be stiffness of the neck, back, and legs due to irritation of the meninges (lining of the brain and spinal cord).

Muscle pain and spasms may occur.

Paralytic poliomyelitis (0.1-0.5% of cases):

Flaccid paralysis: Sudden onset of asymmetrical paralysis (commonly affecting the legs more than the arms).

Spinal polio: Affects the motor neurons in the spinal cord, causing limb paralysis.

Bulbar polio: Affects cranial nerves, leading to difficulty in breathing, swallowing, and speech due to paralysis of the muscles in the throat and chest.

Bulbospinal polio: Combination of spinal and bulbar symptoms, causing severe paralysis and respiratory failure.

Post-polio syndrome (Late complication, years after infection):

A condition characterized by progressive muscle weakness, fatigue, and joint pain years after the initial polio infection. It affects about 25-40% of polio survivors.

5. Risk Factors and Complications

Risk Factors:

- Age: Children under 5 are more susceptible.
- Lack of vaccination: Unvaccinated individuals are at high risk.
- Poor sanitation: Fecal-oral transmission is more common in areas with inadequate sanitation.

- Immunocompromised state: People with weakened immune systems are at greater risk of developing paralytic polio.
- Pregnancy: Pregnant women may be more susceptible to infection, though they rarely develop severe disease.

Complications:

- Permanent paralysis: Paralysis can be irreversible and permanent, particularly in the limbs or respiratory muscles.
- Respiratory failure: Paralysis of the diaphragm and intercostal muscles can lead to respiratory failure, which may require mechanical ventilation.
- Death: Paralysis of the respiratory muscles can result in death if untreated.
- Post-polio syndrome: This long-term complication causes new muscle weakness, fatigue, and pain in previously affected individuals, decades after recovery.

6. Laboratory Diagnosis

Sample Collection:

- Stool samples: The virus is excreted in the feces, making stool the primary sample for viral detection.
- Throat swabs: Early in infection, the virus can be detected in the throat secretions.
- Cerebrospinal fluid (CSF): In cases of non-paralytic and paralytic polio, CSF analysis may show increased white blood cells (pleocytosis), elevated protein, and normal glucose levels.

Diagnostic Methods:

- Viral isolation: Poliovirus can be isolated from stool, throat swabs, or CSF by inoculating cell cultures. The virus is typically grown in human or monkey kidney cell cultures.
- Polymerase chain reaction (PCR): This test detects the viral RNA in samples such as stool, CSF, or throat swabs, offering a highly sensitive and specific diagnosis.
- Serology: Detection of specific antibodies (IgM and IgG) against poliovirus in the blood can indicate current or past infection.

7. Treatment

Supportive Care:

- Bed rest: Helps reduce muscle activity and prevents further damage during the

acute phase.
- Pain management: Non-steroidal anti-inflammatory drugs (NSAIDs) or acetaminophen for fever and muscle pain.
- Physical therapy: Vital for patients with paralysis to maintain muscle function and prevent deformities during recovery.
- Mechanical ventilation: Required for patients with bulbar polio or those experiencing respiratory failure due to paralysis of the respiratory muscles.
- Orthopedic devices: Used to assist in mobility or prevent further musculoskeletal damage in paralyzed limbs.

Medications:

- Analgesics: For pain relief.
- Muscle relaxants: For muscle spasms and stiffness.

Vaccination:

- Inactivated Poliovirus Vaccine (IPV):
- Administered via injection.
- Safe, as it contains inactivated (killed) virus. It cannot cause polio.
- Used globally as part of routine immunization schedules.

Oral Poliovirus Vaccine (OPV):

- Live-attenuated vaccine given orally.
- Induces both humoral and gut immunity, providing better protection against fecal-oral transmission.
- Rare risk of vaccine-derived poliovirus (VDPV) or vaccine-associated paralytic polio (VAPP).

Vaccination Schedule:

- IPV: Given in a 4-dose schedule: 2 months, 4 months, 6-18 months, and a booster at 4-6 years.
- OPV: Administered at birth, 6, 10, and 14 weeks, followed by booster doses in childhood.

8. Prevention

- Vaccination: The most effective preventive measure against polio. High coverage rates are essential to prevent transmission and outbreaks.

- Sanitation: Improvements in water supply and sewage treatment reduce the risk of fecal-oral transmission.
- Hygiene practices: Encouraging handwashing and maintaining clean environments can help limit the spread of the virus.

Conclusion

- Polio is a highly infectious disease caused by the poliovirus, primarily transmitted via the fecal-oral route. Most infections are asymptomatic, but in a small percentage, the virus can invade the central nervous system, causing paralysis. Vaccination is the most effective method of preventing polio, with both IPV and OPV playing critical roles in global eradication efforts. There is no specific antiviral treatment for polio, and care is supportive. Laboratory diagnosis relies on viral isolation, PCR, and serology, while prevention is achieved through immunization and improved sanitation.