

## Diagnosics of the Origin of Poliomyelitis and Modern Diagnostic Methods

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**Abstract:** Polio is a viral infection that most often develops in children under the age of 5. It damages nerve cells in the brain and spinal cord, and in severe cases leads to paralysis of the limbs, trunk, and respiratory muscles. Before universal vaccination against polio began, thousands of children around the world were disabled and died from this disease.

**Keywords:** What is poliomyelitis, Mechanisms of infection and causes of poliomyelitis, Classification of poliomyelitis, Symptoms of poliomyelitis, Complications of poliomyelitis, Laboratory diagnostics, Instrumental diagnostics, Differential diagnostics

### What is polio?

Poliomyelitis or Heine-Medina disease is an acute viral infection that is easily transmitted from person to person. It is very rare in children under 5 years of age, in adults; The target of the virus is the nerve cells of the spinal cord and, less commonly, the brain. In most cases, the disease is asymptomatic or manifests itself with fever, headache and muscle pain, nausea and vomiting. However, in one out of every 200 cases, permanent paralysis of the arms or legs develops. Sometimes it affects not the limbs, but the respiratory muscles, which can lead to death.

This disease was known in Ancient Egypt and the ancient world: Hippocrates wrote a description of the disease, the symptoms of which are very similar to polio. However, the first scientific studies of this pathology began only in the 19th century. At the beginning of the last century, deadly epidemics of this disease occurred every few years. In the USA alone, the 1916 epidemic claimed the lives of 6 thousand people, and in the summer of 1921, 2 thousand people died and about 7 thousand more were disabled. This prompted scientists to search for a vaccine, and social activists and politicians to help prevent this disease. In 1948, a polio vaccine was invented, and in the late 1980s, the WHO adopted a program to eradicate this disease from the world.

In the mid-1950s, American immunologists transferred vaccine samples to their colleagues in the USSR, and starting in 1960, polio vaccination became mandatory in the Soviet Union, as a result of which the outbreak of the disease in the country was stopped.

The poliovirus has been eradicated in all countries except Pakistan and Afghanistan. Spontaneous outbreaks of the disease are now rare in the world. However, in recent years, due to the coronavirus pandemic and the growing anti-vaccine sentiment, the number of children vaccinated against polio has decreased in many countries. This threatens new outbreaks of the disease even in areas where polio has not occurred for many years.

To honor those who helped fight polio, the U.S. Postal Service issued a postage stamp in 1957.

US President Franklin Roosevelt suffered from polio in 1921 and founded the National Institutes of Health in 1938. By Leon Perskie, CC BY 2.0, via Wikimedia Commons

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In 1948, American immunologist Hilary Koprowski developed the first polio vaccine and tested it herself. Author: Mariusz Kubik, CC BY 3.0, via Wikimedia Commons

American singer Elvis Presley was vaccinated against polio live on air to draw attention to vaccination. To honor those who helped fight polio, the U.S. Postal Service issued a postage stamp in 1957.

US President Franklin Roosevelt suffered from polio in 1921 and founded the National Institutes of Health in 1938. By Leon Perskie, CC BY 2.0, via Wikimedia Commons

### **Mechanisms of infection and causes of poliomyelitis**

Poliomyelitis is caused by the poliovirus, a member of the enteric virus family. It is highly contagious and resistant: it can survive in water for more than 3 months, in feces and sewage for up to six months, tolerates freezing well, and is not destroyed in the stomach by digestive enzymes. The virus is killed by boiling, ultraviolet light, and chlorine or potassium permanganate solutions.

The causative agent of poliomyelitis is transmitted from person to person, most often by the fecal-oral or household route, less often by airborne droplets. A patient with poliomyelitis, even if the infection is asymptomatic, sheds the virus through the mouth when sneezing and coughing, as well as through feces for several weeks and sometimes months. Sometimes flies can be carriers of the virus.

Poliomyelitis is a disease of dirty hands, in most cases it is transmitted from person to person

The infectious agent enters the human body through the mucous membranes of the intestines or nasopharynx. It spreads throughout the body through the blood and multiplies in the tissues of internal organs. At this stage, the disease is asymptomatic and can be detected using laboratory tests. The incubation period lasts from 4 to 35 days, most often 7-14 days. After this, the infection can manifest itself as fever, chills, muscle pain, headache, and vomiting.

In about 1% of cases, the virus enters the central nervous system and begins to multiply rapidly, destroying motor neurons in the spinal cord and, rarely, nerve cells in the brain. Scar tissue forms in place of the destroyed nerve tissue, and the spinal cord rapidly shrinks in size. This leads to paresis and acute flaccid paralysis of the limbs, often the feet.

In very rare cases, children with weakened immune systems can develop polio after vaccination. This is called vaccine-associated paralytic polio. Its manifestations are similar to those of a person-to-person infection.

### **Classification of poliomyelitis**

In the International Classification of Diseases, 10th revision, acute poliomyelitis is classified as a viral infection of the central nervous system and is designated by code A80. This disease is divided into several types:

A80.0 - vaccine-associated acute paralytic poliomyelitis;

A80.1 - acute paralytic poliomyelitis caused by wild imported virus;

A80.2 - acute paralytic poliomyelitis caused by wild natural virus;

A80.3 - Acute paralytic poliomyelitis, other and unspecified;

A80.4 - acute nonparalytic poliomyelitis;

A80.9 - Acute poliomyelitis, unspecified.

There are several forms of the disease, depending on the method of infection, symptoms, severity, and complications.

### **Poliomyelitis that does not affect the central nervous system**

In most cases, the disease proceeds unnoticed or manifests itself with symptoms of intestinal or acute respiratory infections. There are several forms of this type of poliomyelitis.



Virus carriage. A person is a carrier and transmitter of the virus, but the disease does not manifest itself in any way.

Asymptomatic form. The disease is asymptomatic, the causative agent of poliomyelitis and antibodies to it are detected only through laboratory tests.

Visceral (abortive) form. The disease lasts 2-5 days and is manifested by symptoms characteristic of ARVI or gastrointestinal diseases: fever, sore throat, loose stools, vomiting, abdominal pain.

Meningeal form. Serous meningitis (inflammation of the brain) develops, which is manifested by headache and muscle pain, high fever, vomiting, high blood pressure, and profuse sweating. The prognosis for this form of the disease is favorable, the person recovers completely within 3-4 weeks.

### **Poliomyelitis with damage to the central nervous system**

Paralytic forms of poliomyelitis develop according to one scenario. Within 1-6 days after the onset of the disease, a person experiences headache and muscle pain, fever, nausea and vomiting, and loose stools. At this time, the virus penetrates the central nervous system and manages to destroy 40-70% of the motor neurons of the spinal cord. Then, within 1-3 days, by the 2-3rd week of the disease, paresis or paralysis develops, muscles atrophy, which leads to disability; Symptoms depend on which parts of the spinal cord the virus destroys.

It is believed that paresis develops when up to 70% of neurons are destroyed. If more nerve cells are destroyed, this leads to paralysis.

Spinal form. This accounts for 95% of polio cases, affecting the central nervous system. Patients develop paralysis of the legs, and rarely paralysis of the arms, torso, and neck.

Bulbar form. It proceeds violently with high temperature and fever. Against this background, swallowing is impaired, a person loses the ability to speak, sometimes breathing and cardiac activity are impaired. With a mild course of the disease, the patient's condition improves from the 2nd week, with a more severe form, a person can die on the 1st-7th day of the disease.

Pontine form. Very rare. The virus affects the facial nerve, resulting in paralysis and paresis of the facial muscles.

Mixed form. The virus destroys neurons in different parts of the spinal cord, resulting in symptoms characteristic of several forms of the disease.

Vaccine-associated paralytic poliomyelitis. A rare disease caused by vaccination. The course is similar to that caused by the wild virus. Symptoms appear 4 to 30 days after vaccination.

### **Symptoms of poliomyelitis**

The symptoms of polio vary greatly depending on the form and severity of the disease. Poliomyelitis, which does not affect the central nervous system, is very easily confused with meningitis, ARVI, and intestinal infections.

### **Symptoms of poliomyelitis without damage to the central nervous system:**

- a) elevated temperature,
- b) sore throat,
- c) abdominal and muscle pain,
- d) loose stools,
- e) vomiting,
- f) high blood pressure,
- g) sweating,
- h) Tachycardia.



**Symptoms of damage to the central nervous system of poliomyelitis:**

In the pre-operative period: elevated temperature, gastrointestinal disorders, pain in the back and neck muscles;

During the period of paralysis and paresis (1-3 days after the onset of the first symptoms): loss of muscle tone (most often lower extremities), inability to perform conscious movements, gradual muscle atrophy.

In rare cases, paralysis affects the intercostal muscles and diaphragm, and the person may experience shortness of breath, shallow breathing, and a bluish color to the mucous membranes and skin.

If the cardiovascular system is impaired, tachycardia occurs and blood pressure drops.

**Complications of poliomyelitis**

Non-paralytic poliomyelitis usually occurs without complications and, with full treatment and rehabilitation, resolves without long-term consequences for the patient's health. With paralytic forms of the disease, complications from various organs and systems may occur.

Musculoskeletal system: irreversible muscle atrophy due to paralysis and paresis. Bones become deformed, limbs stop developing normally and become bent, and the person loses the ability to walk. Even if muscle function is restored, many people experience muscle weakness in the affected limbs for several years after suffering from polio.

From the cardiovascular system: tachycardia, development of thrombosis, heart failure, myocarditis.

From the respiratory system: due to disruption of the intercostal muscles, respiratory failure develops up to the complete inability to breathe independently.

Other complications: intestinal paresis, stomach, urinary system, gastrointestinal bleeding often occur.

After severe forms of polio, children remain disabled for life

**Which doctor treats polio?**

Neurologists, orthopedists, and infectious disease specialists treat poliomyelitis. You may also need the advice and assistance of a pediatrician, and in some severe cases, a resuscitation specialist. A preliminary diagnosis is made based on the clinical picture, and laboratory diagnostics and electroneuromyography results are used for confirmation.

**Laboratory diagnostics**

In 2002, Russia, as part of the WHO European Region, was certified as a polio-free country, with only isolated cases of the disease recorded; testing for polio in a private laboratory is not available.

According to the clinical guidelines (treatment protocol) for poliomyelitis and health legislation, the final diagnosis is made at the national reference laboratory in Moscow and one of the five regional reference laboratories (St. Petersburg, Yekaterinburg, Khabarovsk, Stavropol, Omsk).

Almost any biomaterial is suitable for research: nasopharyngeal discharge, blood, cerebrospinal fluid, feces. The virus itself, as well as antibodies to it, are isolated from it. And with the help of molecular genetic testing, you can even identify individual strains of the pathogen and find out what caused the infection - a wild virus or a vaccine.

**Instrumental diagnostics**

Electroneuromyography allows you to assess the general condition of the nervous system, as well as determine how nerve fibers conduct impulses, how and at what speed the muscles respond to signals sent by nerve endings. Using electrodes, electrical impulses are sent to the muscles, and special equipment records the reaction to this stimulus.

**Differential diagnosis**

One of the most characteristic symptoms of paralytic forms of poliomyelitis is the syndrome of acute flaccid paralysis. However, other diseases can also cause it: inflammation of the spinal cord (myelitis), tick-borne encephalitis, botulism, Guillain-Barre syndrome, spinal cord strokes. In addition, spinal cord injuries and neoplasms can cause it. They have a different nature and require specific treatment, so at the first signs of paralysis, careful differential diagnosis is necessary.

### **Treatment of poliomyelitis**

All forms of polio are treated only in a hospital to prevent the spread of the virus and complications. There is no specific treatment for polio. Comprehensive therapy is mainly aimed at relieving symptoms and, if possible, preventing the patient's condition from worsening.

Depending on the form of the disease and its severity, the patient may be prescribed antiviral and immunomodulatory drugs. Antibiotics are indicated for bacterial complications, and antipyretic drugs for fever. The treatment protocol may also include anticonvulsants, diuretics, vitamins, and other drugs.

After the acute period of the disease, the patient is prescribed a rehabilitation course, which may include massage, physiotherapy, neuropsychiatric and speech therapy sessions.

### **Polio prognosis**

Patients with non-paralytic forms of poliomyelitis recover and make a full recovery. The mortality rate for paralytic poliomyelitis in children is 4-6%, and in adults - 10-20%. In about 75% of such patients, the consequences of paralysis and paresis remain, and the muscles do not recover.

### **Preventing poliomyelitis**

Polio is one of the diseases that has been almost completely eradicated by vaccination. The first vaccine against this disease was proposed in the late 1940s by the immunologist Hilary Koprowski from the United States. Later, the American scientist Albert Sabin developed a live oral vaccine, which was adopted by the WHO as the main means of preventing polio worldwide.

Thanks to vaccination, the number of new cases of polio in the world has decreased from 350,000 in 1988 to 33 in 2018.

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