

Poliomyelitis

Poliomyelitis, often called **polio** or **infantile paralysis**, is a viral [paralytic](#) disease. The causative agent, a virus called **poliovirus** (PV), enters the [body](#) orally, infecting the intestinal wall. It may proceed to the [blood](#) stream and into the [central nervous system](#) causing [muscle](#) weakness and often paralysis. An ancient disease, it was first recognized as a medical entity by [Jakob Heine](#) in 1840. Eradication efforts led by the [World Health Organization](#) and [The Rotary Foundation](#) of [Rotary International](#) have reduced the number of annual diagnosed cases from the hundreds of thousands to around a thousand.

Infection

Polio is a communicable disease which is categorized as a disease of civilization. Polio spreads through human-to-human contact, usually entering the body through the mouth due to fecally contaminated water or food. The poliovirus is a small RNA (ribonucleic acid) virus that has three different strains and is extremely infectious. The virus invades the [nervous system](#), and the onset of [paralysis](#) can occur in a matter of hours. While polio can strike a person at any age, over fifty percent of the cases occur in children between the ages of three and five.

The [incubation](#) period of polio, from the time of first exposure to first symptoms, ranges from three to thirty five days, thus Polio can spread widely before a polio outbreak is apparent. Most people infected with the poliovirus have no symptoms or outward signs of the illness and are thus never aware they have been infected. After initial infection with poliovirus, virus particles are excreted in the feces for several weeks and are highly transmissible to others in a community. In all forms of polio, the early symptoms of infection are fatigue, fever, vomiting, headache and pain in the neck and extremities. Around 1% of unimmunized people develop paralytic complications, in some cases [bulbar](#) paralysis.

The cause of the disease

Initial infection is of cells in the lining of the small intestine. Immunization interrupts the process here. After multiplication there, viraemia occurs, with distribution of virus to other parts of the body. Flu-like symptoms are typical of viraemia from any cause. The virus has an affinity for the cell bodies of motor neurons, which carry commands to the muscles.

The rough estimation of distribution of various types of polio are:

- 90% have no or almost no symptoms or their disease is indistinguishable from [influenza](#)
- 9% have non-paralytic polio
- 1% have spinal or bulbar polio, of which:
 - 10% die
 - 50% recover fully
 - 40% are left with only partial recovery or permanent paralysis

Of those 0.4% of polio patients who are left with permanent paralysis, the most affected locations are either or both lower limbs. Quadriplegia or respiratory paralysis occur on only 0.01% (1 in 10,000) of all polio patients.

Non-paralytic polio

Non-paralytic polio may result in fever, vomiting, abdominal pain, lethargy, and irritability, and some muscles tender to the touch. In some cases there may be no significant symptoms whatsoever.

Spinal polio

The virus affects the anterior horn cells in the spinal column which control movement of the trunk and limb muscles including the intercostal muscles. An affected limb becomes floppy and poorly controlled — the condition of acute flaccid paralysis (AFP). This presentation can lead to permanent paralysis of the body yet it only occurs in around 1% of cases. The classic later appearance (as seen in ancient Egyptian illustrations) is of muscle wasting in a leg. Destroyed motor neurons do not regenerate and the affected motor units of muscles will not be able to contract. However, some sprouting from nearby surviving neurons may reinnervate the denervated muscle. This additional load on surviving motor neurons may precipitate the later developing symptoms of post-polio syndrome.

The degree of paralysis is proportional to the extent of infection of the motor nuclei, which is likely to be proportional to the degree of viraemia, and inversely proportional to the degree of immunity. Extensive paralysis of the trunk and muscles of the thorax and abdomen ([quadriplegia](#)) may occur.

If it affects the upper part of the cervical spinal cord (C3-4-5) then diaphragm paralysis requires ventilator support. Without respiratory support, polio affecting respiration is likely to result in death from failure of breathing, or aspiration of secretions and resulting [pneumonia](#). The critical nerves are the phrenic nerve (the cranial nerve driving the diaphragm to inflate the lungs) and the innervation to the muscles needed for swallowing. Skilled clearing of the airway with suction and tracheostomy are part of the care of such a patient, but they can expect to need mechanical ventilation. The tank respirator - [iron lung](#) - has some advantages over positive pressure applied through a tracheostomy and is still in use by a few people. In Europe, the usual treatment is either mask ventilator or tracheal ventilator. Some patients use [cuirass](#) type mechanical ventilators worn over thorax and abdomen.

Bulbar polio

The brainstem is homologous to the spinal cord, but the motor neurons arising from there and passing in the various [cranial nerves](#) control the various muscles of eyeball movements; the trigeminal nerve and facial nerve which innervate cheeks, tears, gums, and muscles of the face, etc; the [glossopharyngeal nerve](#) which in part controls swallowing and functions in the throat, tongue movement and taste; the nerve that sends signals to the heart, intestines, and lungs; and the accessory nerve that controls upper neck movement. Thus, bulbar polio could affect any or all of these functions.

The Copenhagen epidemic has been described as the start of intensive care, when large numbers of patients were ventilated by hand ("bagged") by medical students and anyone else to hand. Nowadays electricity drives the respirators.

The mortality rate of bulbar polio ranges from twenty-five to seventy-five percent [\[1\]](#), according to the age of the person. In 2006 there are still polio survivors who must spend their entire day or most of their day in an [iron lung](#) or attached to an assistive respiratory machine to stay alive. Bulbar polio and spinal polio are part of a continuum of anatomy and disease (paralytic polio). Approximately one in 1000 people who have had paralytic polio have permanent respiratory paralysis.

Fulminating encephalitis (an overwhelming invasion of the virus into other parts of the brain) is rare, but is most often lethal."

Polio and children

Young children who contract polio may sometimes suffer only mild symptoms, and as a result they may become permanently immune to the disease. Hence inhabitants of areas with better sanitation may actually be more susceptible to polio because fewer people have the disease as young children.

People who have survived polio sometimes develop additional symptoms, notably muscle weakness and extreme fatigue, decades later; these symptoms are called [post-polio syndrome](#). Since it's possible to have a polio infection without having significant paralysis, many people who are unaware they ever had polio may now be suffering from post-polio syndrome.

History

The effects of a polio infection have been known since [prehistory](#). [Egyptian](#) paintings and carvings depict otherwise healthy people with withered limbs, walking with canes at a young age, etc. It has been theorized that the [Roman Emperor Claudius](#) was stricken as a child, and this caused him to walk with a limp for the rest of his life. The first medical report on poliomyelitis was by Jakob Heine in 1840. [Karl Oskar Medin](#) was the first to empirically study a poliomyelitis epidemic in [1890](#). The work of these two physicians has led to the disease being known as the Heine-Medin disease.

Franklin D. Roosevelt may have contracted polio in 1921. Yet his age (39 years) and many features of his illness are more consistent with a diagnosis of [Guillain-Barré syndrome](#) (an autoimmune [peripheral neuropathy](#)). A peer-reviewed study published in 2003, ^[1] using Bayesian analysis, found that six of eight posterior probabilities favored a diagnosis of Guillain-Barré syndrome over poliomyelitis. Regardless of the cause, the result was that Roosevelt was totally and permanently paralyzed from the waist down. He could sit up and, with aid of leg braces, stand upright, but could not walk. Although the paralysis (whether from poliomyelitis or [Guillain-Barré syndrome](#)) had no cure at the time, for the rest of his life Roosevelt refused to accept that he was permanently paralyzed. He tried a wide range of therapies, but none had any effect. Nevertheless, he became convinced of the benefits of hydrotherapy, and in 1926 he bought a resort at [Warm Springs, Georgia](#), where he founded a hydrotherapy center for the treatment of polio patients which still operates as the [Roosevelt Warm Springs Institute for Rehabilitation](#) (with an expanded mission). Furthermore, after he became President, he helped to found the National Foundation for Infantile Paralysis (now known as the [March of Dimes](#)), that supported the rehabilitation of victims of paralytic polio and the discovery of the polio vaccines.

Failures and scandals

There were other proposed vaccines introduced before [Jonas Salk's vaccine](#) in 1953. In 1935 W. H. Park and Maurice Brody, a research assistant at New York University, claimed to have discovered a vaccine procured from ground up monkey spinal cords. Brodie tested the vaccine on himself and several of his assistants. He gave the vaccine to three thousand children and many developed allergic reactions, but no immunity to polio. Other researchers could not replicate his experiment.

Philadelphia pathologist John Kolmer also claimed to have developed a vaccine that same year, and not only was that false, but it proved to be fatal to a number of children ^[2].

In the [1950s](#) millions of dollars were invested in finding and marketing a [polio vaccine](#) by commercial interests, including Lederle Laboratories in New York under the direction of [H. R. Cox](#). Polish-born virologist and immunologist [Hilary Koprowski](#), who also worked at Lederle, claims to have created the first successful polio vaccine (in [1950](#)) but his vaccine, a live attenuated virus taken orally, was still in the research stage and would not be ready for use until five years after [Jonas Salk's](#) polio vaccine (a dead injectable vaccine) reached the market. [Albert Sabin](#) used samples of difficult to manufacture attenuated virus given to him by Hilary Koprowski to make his own version. "Koprowski would later complain that the polio vaccine he had discovered became known as the Sabin vaccine." ^[3] ^[4] Koprowski's own

vaccine was ultimately tested, but the outcome was a failure. After the attenuated live virus entered the body, it sometimes reverted to a virulent state [5]. Nevertheless, from 1957 to 1960, large scale tests were carried out in the [Congo](#). The results have been controversial [6].

The Simian Virus known as [SV40](#) was also present in many polio vaccines from 1954 to 1962. The U.S. [Food and Drug Administration](#) and the [Centers for Disease Control and Prevention](#) have taken the lead in responding to questions on SV40 and polio vaccine. CDC states that SV40 markers have been found in certain types of human cancers, but it has not been determined if SV40 plays any role in these cancers. A recent report published by the Institute of Medicine of the National Academy of Sciences concluded that "the evidence is inadequate to accept or reject a causal relationship between SV40 containing polio vaccines and cancer." There is a need for further research to answer questions that have been raised concerning this possible relationship. More detailed information on SV40 and the polio vaccine can be found at the [CDC Web site](#).

An analysis presented at the Vaccine Cell Substrate Conference in 2004 [7] suggested that vaccines used in the former Soviet bloc countries, China, Japan, and Africa, could have been contaminated up to 1980, meaning that hundreds of millions more could have been exposed to the SV40 virus.

Vaccine-derived polio

The oral polio vaccine (Sabin or OPV) can revert to a virulent form. This is believed to be a rare event, but outbreaks of vaccine-derived poliovirus (VDPV) have been reported, and tends to occur in areas of low coverage by OPV. [2][3][4] There is currently (14 Aug 2006) an outbreak of vaccine-derived poliovirus in China. [5] This sort of polio outbreak only occurs in areas of low vaccine coverage, presumably because the OPV is itself protective against the related outbreak strain.

First effective vaccine

The first effective [polio vaccine](#) was developed by [Jonas Salk](#) at the [University of Pittsburgh](#), although it was the oral vaccine developed by [Albert Sabin](#) eight years later that was used for modern mass inoculation. The Salk vaccine is based on formalin-inactivated poliovirus. The Sabin vaccine is a live-attenuated vaccine, produced by the passage of the virus through non-human cells at a subphysiological temperature. The first [immunization](#) of children against polio began at Arsenal Elementary School and the [Watson Home for Children](#) in [Pittsburgh, Pennsylvania](#) in 1954. Through mass immunization, the disease was wiped out in the Americas, although it recently has re-appeared in [Haiti](#), where political strife and poverty have interfered with vaccination efforts. [8]

Recent eradication efforts

Number of cases [9] [10] [11] [12]:

- 1988: 350,000
- 1996: 4,074
- 1997: 5,185
- 1998: 6,349
- 1999: 7,141
- 2000: 2,971
- 2001: 498
- 2002: 1,922
- 2003: 784
- 2004: 1,258
- 2005: 1,998

1988

In 1988, the [World Health Organization](#) passed a resolution to eradicate polio by 2000, a measure which was inspired by [Rotary International](#)'s 1985 pledge to raise \$120 million toward immunising all of the world's children against the disease. The next plan called for a stop of spreading the virus by 2005. Most remaining polio infections are located in two areas: the Indian sub-continent and [Nigeria](#). Eradication efforts in the Indian sub-continent have met with a large measure of success. The Indian Government started the [Pulse Polio](#) Campaign to get rid of polio. Most families allowed their children to take the vaccine.

1994

On 20 August the Americas region was certified as polio-free.

- [Read about the certification](#)

1995

Operation Mecacar (Mediterranean, Caucasus, Central Asian Republics and Russia) is launched: from now on, National Immunization Days are coordinated in 19 adjacent countries of the European and Mediterranean regions of [WHO](#).

2002

The World Health Organization announces that Europe is polio-free.^[13] Certification took place on [June 21](#) in the [Copenhagen Glyptotek](#).^[14]

2003

In the [Kano](#) province in Northern Nigeria, which operates under [Sharia](#) (Muslim religious law), the immunisation campaign was suspended in September [2003](#) when prominent Muslim leaders said they suspected that vaccines supplied by Western donors were adulterated to reduce fertility and spread [HIV](#) as part of a [U.S.-led](#) drive against [Islam](#).^[15] On [June 30, 2004](#), the WHO announced that Kano had pledged to restart the campaign in early July, after a 10-month ban during which the virus spread across Nigeria and into 10 other African countries that were previously polio-free.

In addition to the rumors of sterility and the ban by Nigeria's Kano state, civil war and internal strife in the countries of Sudan and Ivory Coast have complicated WHO's polio eradication goal.

2005

1,831 cases of wild poliovirus (excludes [vaccine](#) derived polio [viruses](#) ^[16]).

- 727 Nigeria (endemic)
- 478 Yemen (importation)
- 299 Indonesia (importation)
- 154 Somalia (importation)
- 64 India (endemic)
- 27 Pakistan (endemic)
- 27 Sudan (re-established transmission)
- 20 Ethiopia (importation)
- 9 Angola (importation)
- 9 Niger (endemic)
- 7 Afghanistan (endemic)

- 4 Nepal (importation)
- 3 Mali (importation)
- 1 Chad (re-established transmission)
- 1 Eritrea (importation)
- 1 Cameroon (importation)

Source: [Polio cases from 1 January 2005, as of 17 January 2006](#)

- **Nigeria:** "Fifty-four new polio cases were recorded in [Nigeria](#) between February and April, a drop of nearly a half from last year, according to the World Health Organisation. The infection rate is down from the 91 cases recorded between 27 February and 29 April [2004](#), WHO said in its weekly report obtained on Thursday. The report said nine new cases were confirmed in Yobe state and Nigeria's biggest city, Lagos—the first in the southern region where WHO said there had been no fresh infections since September. WHO said improved control in the southern states and resumed immunisation in the north, where Muslim clerics led a boycott of vaccination in late 2003, explained the drop in new infections." <http://www.alertnet.org/thenews/newsdesk/L05627944.htm>
- **Sudan:** "Since the beginning of 2005, the ICRC's various primary health clinics have managed to immunise more than 99,000 children under five years of age against poliomyelitis. In all, 78,654 children were immunised in Darfur (Seleia, Zalingei, Kutum and Gereida) and 20,432 in southern Sudan (Yirol and Chelkou). The first case of the polio outbreak in Sudan was detected in May 2004. Since then, health organizations have registered cases in 17 of the 26 states of the country. The Sudanese health authorities have intensified the national immunisation campaign and the ICRC has provided its support, particularly in conflict-affected regions." <http://www.noticias.info/asp/aspComunicados.asp?nid=65088&src=0>
- **Yemen:** "More than 40 new cases of polio have been confirmed in [Yemen](#), the World Health Organization said yesterday, more new cases than in any other nation. ... Epidemiologists expect the 63 cases confirmed thus far in Yemen, a poor country on the southern tip of the Arabian peninsula, to grow to more than 100 soon." [nytimes 2005/05/11](http://nytimes.com/2005/05/11)
- **India:** [India](#) has used the [Pulse Polio](#) campaign to increase polio immunisation rates. India recorded 4,791 cases of polio in [1994](#), 1,600 in [2002](#), 225 in [2003](#), and 135 in [2004](#). <http://onlypunjab.com/fullstory2k5-insight--status-22-newsID-25278.html>
- **Pakistan:** "In [2003](#), we had around 103 reported cases of polio, which dropped by almost 50 percent in [2004](#) with a total of 53 cases registered. Now, so far in [2005](#), a total of only five polio cases have been reported, Jeffery Bates, polio communications officer at the United Nations Children's Fund (UNICEF) told IRIN on Thursday, the concluding day of the national polio immunisation campaign." <http://www.plusnews.org/report.asp?ReportID=46851&SelectRegion=Asia&SelectCountry=PAKISTAN>
- **Indonesia:** On [May 5 2005](#), news reports broke that a new case of polio was diagnosed in Java, [Indonesia](#) and the virus strain was suspected to be the same as the one that caused the outbreak in Nigeria. http://www.theglobeandmail.com/servlet/ArticleNews/TPStory/LAC/20050505/BCPA_CIFIC05-4/TPHealth/http://news.yahoo.com/s/ap/20050505/ap_on_re_eu/polio_spreads;_ylt=AvPizOCAGpxnDUkXEb7Ap0Gs0NUE;_ylu=X3oDMTA2bXJyZDI0BHNIYwNobA. New public fears over vaccine safety, which were unfounded, impeded vaccination efforts. In summer 2005 the WHO, UNICEF and the Indonesian government made new efforts to lay the fears to rest, recruiting celebrities and religious leaders in a publicity campaign. <http://www.guardian.co.uk/elsewhere/country/story/0,7792,1561473,00.html>
- **United States:** "On [September 29 2005](#), the Minnesota Department of Health (MDH) identified poliovirus type 1 in an unvaccinated, immunocompromised infant girl aged 7 months (the index patient) in an [Amish](#) community whose members predominantly were unvaccinated for polio. The patient has no paralysis; the source of the patient's

infection is unknown. Subsequently, poliovirus infections in three other children within the index patient's community have been documented." [CDC](#)

Famous polio survivors

- [Alan Alda](#), actor
- Sir [Arthur C. Clarke](#), scientist and science fiction author
- [Francis Ford Coppola](#), film director
- [Ian Dury](#), rock musician
- [Mia Farrow](#), actress
- [Michael Flanders](#), British actor, broadcaster, and writer
- [Arthur Guyton](#), physiologist
- [Jack Nicklaus](#), golfer
- Stanley Orr, [Fleet Air Arm fighter ace](#)
- Yitzhak Perlman, violinist
- [Wilma Rudolph](#), athlete, later Olympic gold medalist
- [Johnnie Baima](#), drag queen