



Institute of
Biomedical
Science

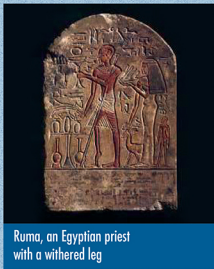
Polio and its syndromes

Polio is a disease that is on the brink of eradication yet has demonstrated yet again that man ignores tiny viral life forms at his peril.

Polio virus under the electron microscope

Vaccine and vaccine controversy

- Inactivated poliovirus (IPV):
- Jonas Salk developed a formalin-inactivated vaccine, first tested in 1952, which came into clinical use in 1955
- 1935: Brodie tried a suspension of PV taken from infected monkey spinal cord as a vaccine inactivated with 10% formalin. First used on 20 monkeys, then on 3000 Californian children. The results were poor and additional human studies were never performed
- In the same year, Kollmer tried a live, attenuated virus consisting of a 4% suspension of PV from infected monkey spinal cord, treated with sodium ricinoleate. He used it on monkeys and then on several thousand children. Acute paralysis occurred in about one in 1000 of those vaccinated shortly after administration, and some cases were fatal.
- Attenuated poliovirus:
- 1961: Oral polio vaccine developed by Albert Sabin and introduced into commercial use.



Ruma, an Egyptian priest with a withered leg

Early evidence

- Skeletons from the Bronze and Iron Age.
- 18th Dynasty Egyptian frieze (1570–1342 BC) shows Ruma, a guardian priest of the Temples of Asarte, with a withered and shortened leg.

First description:

- **Clinical**
- 1734: Jean-Godefroy Salzmann, dissertation on *A defect of many muscles of the foot*. Sudden onset in childhood; paralysed and wasted right leg. He did not give the condition a name.
- 1813: Giovanni Battista Monteggia – sudden infant paralysis of the legs following diarrhoea and fever.
- 1789: First proper description, probably by London physician Michael Underwood – *Treatise on diseases of children* 2nd edition – Debility of lower extremities, paralysis in the legs of children aged 1–4 years. He thought this was a new description.
- 1840: First coherent analysis by Jacob Heine – paralysis after mild fever, concluding it was due to spinal cord damage. In 1860 he published *Spinalne Kinderlähmung*.

Microscopical

- 1870: Jean-Martin Charcot and Alfred Vulpius both reported lesions of the anterior horn of the grey matter of the spinal cord. Inflammation, with phagocytes engulfing the remains of damaged motor neurones.

The naming of the disease

- 1789: Debility of lower extremities:
- 1830: Lähmungszustände der unteren Extremitäten
- **Kinderlähmung:**
- Infantile paralysis
- Late 1930s: realisation that it was not just a disease of children, and became known as poliomyelitis or polio.
- Figuratively: 'Worming Paralysis'; 'The Crippler'; 'Heine-Medin Disease'.

Cause

- Heine blamed teething.
- 1885: Mary Putnam Jacobi first to propose an infection by an unknown 'bacterium'.
- 1908: Karl Landsteiner in Vienna – filterable virus – transmission to monkeys:
 - ground spinal cord from a nine-year-old boy.
 - Confirmed by Constantin Levaditi at the Pasteur Institute in Paris.
- Many thought that 'polio' virus was a 'bandwagon':
 - Blamed poisonous weeds, electrical appliances, chemical toxins, foods, fruit and vegetables, sugar, cows' milk – the list goes on. As late as 1951 there were still those who dismissed a viral cause for the disease.
- 1911: In Sweden, Carl Kling, Wilhelm Wernstedt and Alfred Pettersson found that saline run through the intestine of post-mortem could paralyse monkeys. So could washings from living polio patients.
- 1916: Findings presented at 15th International Congress of Hygiene and Demography in Washington DC, USA: they were ignored.
- Preferred theory was transmission by biting stable flies, which was proposed by the Americans Rosenau and Brues.
- 1941: Sabin found polio virus in the intestinal wall of victims:
 - In about 95% of all polio cases, the person has no symptoms. These are known as asymptomatic cases. The remainder of cases can be divided into three types: abortive polio, non-paralytic polio and paralytic polio:
- **Abortive polio:** In these cases, polio is a mild illness, with viral-like symptoms such as fever, fatigue, headache, sore throat, nausea and diarrhoea.
- **Non-paralytic polio:** These cases typically involve the symptoms of abortive polio, with additional neurological symptoms such as sensitivity to light, and neck stiffness.
- **Paralytic polio:** The first signs of paralytic polio, after an initial period of viral-like symptoms, typically begin with loss of superficial reflexes, and muscle pain or spasms. Paralysis, usually asymmetric, follows. Fewer than 1–2% of people who contract polio become paralysed. In most cases of paralytic polio, the patient recovers completely. However, for a certain number of people, paralysis or muscle weakness remains for life.



Paralysed patient in an iron lung

A look at the virus

- The assumption that there is more than one type of polio virus (PV) was launched by Burnet and Macnamara in 1931, and confirmed by Paul and Trask by observation in monkey experiments.
- 1936: Sabin and Oltsky reported that PV could be grown *in vitro* in human embryonic neuronal tissue fragments cultivated in glass vessels.
- 1949: Bodian and Morgan demonstrated that there are three immunological types:
 - The three distinct types were identified by a prototype strain, Brunhilde (type I), Lansing (type II) and Leon (type III)
 - Type 1 caused most epidemics and 80% of all cases of paralysis
 - Type 2 (rare and benign) caused 7% of cases of human paralysis (unlike the other two types, it is able to infect and paralyse mice)
 - Type 3 caused about 13% of cases of paralysis
 - Antibodies from one 'type' do not protect against other 'types'
 - A trivalent vaccine was needed.
 - 1949: Enders, Weller and Robbins successfully cultured the Lansing strain in non-neuronal tissue culture.
- Early 1950s: Virus first visualised by electron microscopy as a spherical structure. It is now known to be a plus-stranded RNA (~7.5 kb) virus with a 30 nm icosahedral capsid.
- 2008: Genus Poliovirus was reclassified as human enterovirus C, a member of the Picornoviridae family.

Albert Sabin (1906–1993)

Epidemiology, outbreaks and social impact

- Small outbreaks reported in various parts of Europe during the mid-1800s.
- 1890: A Swedish professor of paediatrics reported an outbreak around Stockholm, affecting the whole body, with paralysis only if spinal cord attacked; preceded by fever, malaise, diarrhoea and headache. First to suggest it was an epidemic disease, but thought it was miasm.
- 1904: Ivar Wickman recorded 1031 cases in an outbreak, concluding person-to-person spread, and proposed asymptomatic carriers. Argued that cases should be reported to public health authorities.
- 1932: Concept of poliomyelitis as an enteric infection introduced when Paul and Trask found the virus in faeces, and they recovered virus over a period of weeks from patients and healthy contacts.
- Melnick published a paper: sewage water testing in New York during periods when paralytic polio was prevalent, and a ratio of 100 subclinical infections for every paralytic case was estimated.
- Summer transmission of infection was associated with increased quantities of PV in sewage water.
- Two phases of disease, the gastrointestinal infection followed by viraemia, and central nervous system (CNS) invasion was confirmed by laboratory studies.

Treatment and prevention

- Quack remedies.
- Iron lung.
- Collipiers etc.
- By 1952, serological studies established that the antibodies against PV were present in the patient shortly after the onset of the disease, and increased during convalescence. In 1952, a field trial conducted by Hammon showed that passive immunisation by gammaglobulin administration provided protection against the disease for only two to five weeks.
- Public health measures introduced.
- Swimming pools closed.

Post-polio syndrome

- Post-polio syndrome (PPS, or post-poliomyelitis syndrome or post-polio sequelae) is a condition that affects approximately 25–80% of people who have previously survived an acute attack of poliomyelitis — a viral infection of the nervous system — after the initial infection. Typically, the symptoms appear 15–30 years after recovery from the original paralytic attack, at an age of 35–60. Symptoms include acute or increased muscular weakness, pain in the muscles, and fatigue. The same symptoms may also occur years after a non-paralytic polio (NPP) infection.
- The precise mechanism that causes PPS is unknown. It shares many features with chronic fatigue syndrome, but, unlike that disorder, it tends to be progressive, and can cause loss of muscle strength.



Jonas Salk (1914–1995)

Eradication programme

- 1988: Programme to eradicate polio was led by WHO, UNICEF and the Rotary Foundation:
- Infant oral polio vaccine (OPV), four doses in first year of life in developing and endemic countries
- National Polio Days – OPV given to children under five
- Active surveillance
- Map-up vaccination.

Current situation

- 2016: Wild-type polio virus type 1 still endemic in Afghanistan and Pakistan.
- Two cases of acute flaccid paralysis polio caused by type 1 virus reported in Nigeria – a continuation of the 2014 Borno State outbreak.
- Circulating vaccine-derived polio cases have occurred in a number of countries.
- Two young children in Ukraine contracted polio in Europe's first confirmed outbreak of the paralytic disease since 2010.

Polio 'names'

- Mary Berry, Ian Durry, Adrian Adegitan, Joni Mitchell, Jack Nicklaus, Emperor Claudius, and possibly US President Franklin D Roosevelt (although this may have been Guillain-Barré syndrome).

Forgotten, but not gone:
old diseases that can still bite

Produced by members of the
History Committee for Congress 2017

