Pathogenesis and communicability

The poliovirus is a highly infectious entero-virus transmitted mostly via the oral-faecal route, but oral-oral transmission may also be possible. The virus inhabits the pharynx and gastro-intestinal tract and is present in the throat and stools before the onset of disease. The incubation period for poliomyelitis is usually 6–20 days but may range from 3–35 days. There are three serotypes of polio – P1, P2 and P3. Immunity against one serotype does not warrant immunity against the other two, hence the use of trivalent polio vaccinations.1

The virus invades local lymphoid tissue, enters the blood stream and from there may infect the central nervous system. In patients where the virus affects the anterior horn and the brain stem, the result is typical paralytic symptoms of poliomyelitis. Infected persons are most infectious 7–10 days before and after the onset of symptoms.1

Clinical presentation

The majority of patients (up to 95%) remain asymptomatic after infection. They do however shed the virus and are able to infect others. Minor illness is experienced by around 4–8% of patients. Symptoms include upper respiratory tract infections, gastro-intestinal disturbances and influenza-like illness. This clinical presentation is known as abortive poliomyelitis and is not clinically distinguishable from other viral illnesses.1

Another 1–2% of patients may experience non-paralytic aseptic meningitis presenting as stiffness of the neck, back and legs that may last from 2–10 days followed by complete recovery. Abnormal or increased sensations may also be present. Flaccid paralysis occurs in less than 1% (1 in every 200) of infected patients. Paralysis usually starts within 1–10 days of the initial prodrome and progresses for 2–3 days. Once temperature returns to normal, no further paralysis develops. Initial minor symptoms are often separated by a 1–7 day period after which major symptoms appear. Initial symptoms may include a loss of superficial reflexes, increased deep tendon reflexes and severe muscle aches and spasms in the limbs or back. Illness progresses to flaccid paralysis, usually asymmetric, with diminished deep tendon reflexes. Symptoms reach a plateau without any changes for days to weeks after which strength begins to return. Weakness or paralysis that is still present 12 months after onset is usually permanent.1

Paralytic polio is classified as either spinal polio, characterised by asymmetric paralysis mostly involving the legs, bulbar polio affecting brain stem cells innervating respiratory muscles and leading to difficulty in breathing, or bulbospinal polio – a combination of the two. Around 2–5% of children and 15–30% of adults contracting paralytic polio die and the incidence increases with bulbar involvement.1

Thirty to forty percent of patients who contracted paralytic polio in childhood experience new muscle pain and exacerbation of existing weakness, or develop new weakness or paralysis 30–40 years later. This syndrome, known as postpolio syndrome, is not an infectious process and the patient is not shedding the virus.1

History of polio vaccination

Evidence of sporadic polio epidemics was found in Egypt from as early as 1403 and 1365 BC depicted in an Egyptian stele as a crippled young man with a withered and shortened right leg and his foot held in a typical position characteristic of flaccid paralysis.3 The first clinical description of polio was presented by a British physician, Michael Underwood, in 1789.3 4 The first outbreak in Europe was recorded in the early 19th century and the first polio epidemic in the United States killed 6 000 people and paralysed 27 000 more in 1916. In the 1950s there were more than 20 000 cases of polio each year. 4

These figures were changed dramatically when a successful trial performed in 1954 with inactivated polio vaccines developed by Salk and his associates was announced in 1955. Vaccination started in 1955 in the US and the number of polio cases fell significantly.
by 85–90% by 1959. From 1957–1959 trials with live oral polio vaccines (OPV) took place in Russia and OPV became the preferred method of vaccination due to low cost and easy administration. 1979 saw the last report of wild type polio in the US as well as the last report of small pox in the world. In 1988 there were over 350,000 cases of polio in more than 125 countries worldwide. This was reduced to only 784 cases reported in 6 countries by 2003 – a reduction of 99%. The last reported case of polio in South Africa was in 1989. South Africa was declared polio-free by the Africa Region Certificate Commission on 17 October 2006.

**Vaccination**

Trivalent oral polio vaccines (OPV) are the vaccines of choice in countries with wild-type poliomyelitis transmission. With the vaccine being cheap and easy to administer, large populations can be vaccinated to provide excellent intestinal immunity that prevents infection with the poliomyelitis virus. Vaccination of one patient with OPV results in immunity in close contacts as it produces intestinal immunity and also provides herd immunity in communities.

Inactivated poliomyelitis vaccines (IPV) appear to produce less intestinal immunity and are associated with immunity due to antibodies. These patients may be infected with wild-type polio more readily than OPV recipients. However, if OPV continues to be used for vaccination after eradication of wild-type poliomyelitis, vaccine-derived polio virus (VDPV) will persist with the risk of vaccine-associated paralytic poliomyelitis (VAPP) becoming more prominent. (See below). One of the proposed strategies is to switch to IPV before discontinuation of polio vaccination in order to eliminate circulating vaccine-derived polio virus.

Poliomyelitis outbreaks in industrialised countries may be prevented with overall population immunity levels of 66-80%. In contrast, outbreaks in developing countries with poor sanitation and hygiene could still occur with immunity levels as high as 94-97%. In outbreak situations where the serotype of poliomyelitis is known, the use of the relevant monovalent polio vaccine (mOPV) is preferred. mOPV provides higher seroconversion rates than trivalent OPV.

**Vaccine Associated Paralytic Poliomyelitis (VAPP) and Vaccine Derived Poliomyelitis Virus (VDPV)**

- **VAPP**
  
  Vaccine-associated paralytic poliomyelitis (VAPP) is a rare adverse reaction occurring in 1 out of 2.4 million doses of oral polio vaccine administered. The live virus in the vaccine moves through the intestines without providing intestinal immunity and mutates in the vaccinated patient to form what is called revertants. Reversion occurs in almost all vaccine recipients but only rarely causes VAPP. Because the mutated polio virus is shed in the stools of the patient for up to 6 weeks after vaccination, contacts may also be infected and infected with this virus (that reacquired wild virus characteristics) if they come in contact with the stools of the vaccinated patient. Shedding is highest for 1–2 weeks after vaccination and particularly after the first ever dose of the vaccine.

Paralysis identical to that caused by the wild-type poliomyelitis virus can occur rarely in vaccine recipients, as well as the contacts of vaccine recipients. Persons over the age of 18 years are more likely to develop VAPP than younger children. Patients with certain types of immuno-deficiencies (particularly B-lymphocyte disorders) stand a 7000 times higher risk of contracting VAPP than immuno-competent children. The risk for contracting VAPP is also higher with administration of the first dose and in older contacts that have not been vaccinated previously.

- **VDPV**
  
  Vaccine derived poliomyelitis viruses are live polio viruses from vaccination that persist and mutate either in patients that are immunocompromised (iVDPV), or circulate in the community (cVDPV) or in the environment, usually in the sewage (aVDPV). cVDPV infection is likely to occur in communities where immunity levels are low due to a drop in vaccination uptake and low intestinal immunity. The virus from the vaccine is then able to circulate and mutate to become neurovirulent.

**Eradication**

Since 1988, the WHO, Rotary International, PanAmerican Health Organisation, CDC and UNICEF began the international campaign to stop transmission of polio everywhere in the world.

The objectives of the initial Global Polio Eradication Initiative in 1988 were to:

- Eradicate wild polioviruses
- Control remaining viruses (VDPV and laboratories)
- Stop polio immunisation

In order to eradicate wild polioviruses, four strategic pillars for the eradication of poliomyelitis have been identified:

1. Routine immunisation with oral polio vaccine
2. Surveillance of wild virus circulation
3. Supplemental immunisation activities (SIA)
4. Targeted "mop-up" immunisation campaigns

Eradication of polio poses some additional challenges that were not experienced with the eradication of smallpox. This is mainly because infection with the polio virus is rarely clinically apparent with non-specific acute flaccid paralysis (AFP) and can only be positively identified with laboratory testing. As opposed to the single serotype of smallpox, three serotypes of the polio virus exist and in addition, revertants (mutated vaccine viruses) may also spread the disease.

Another challenge in the process of eradication is the recurrence of polio in previously polio-free countries due to importation via travellers. A 12-month suspension of polio vaccination in Nigeria caused resurgence of poliomyelitis which spread from Nigeria to other countries. This increased the number of polio cases from 784 in 6 countries in 2003 to 1,595 cases in 23 countries in 2009.
Polio

Conclusion

In order to maintain polio-free status in South Africa, intensified monitoring to identify any imported polio is required. In the event that imported polio should be identified, measures need to be in place to act swiftly to prevent spread to the community. This emphasises the importance of also maintaining high levels of routine immunisation.

Eradication of polio, though it may be a complex, challenging process, is achievable but will require commitment and dedication from healthcare workers around the globe. For more information on Global Polio Eradication, visit www.polioeradication.org/.

References:
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