Polio: General Characteristics

Poliomyelitis is highly infectious disease that can result in irreversible paralysis (one in two hundred infections) and in severe cases death (5% to 10% of those become paralysed). There is currently no cure for poliomyelitis and so the vaccination was a major breakthrough in tackling this disease. Jonas Salk is known for the creation and discovery of vaccination for poliomyelitis in 1955, as well as his involvement in campaigning for mandatory vaccination. There are three serotypes of the virus and the first vaccine was an inactivated poliomyelitis injection developed, which protects against all three, and is currently on the World Health organisation list as an essential medicine. Combined with the oral vaccine, poliomyelitis has been eliminated from most of the world.

Infection is due to the contact with faecal matter from a person who carries the poliovirus. It enters and then develops within the throat and intestines, but may progress into the central nervous system, damaging nerve cells. Around the world, a microenvironment of low hygiene is created by younger children within families which readily facilitates faecal-oral and oral-oral transmission, increasing the spread of the virus. Once inside the throat and intestines, poliomyelitis attaches to the receptors on the epithelium and begins to replicate within these cells. Spread is then due to the poliomyelitis virus entering the lymphatic system where it is able to enter the bloodstream and then central nervous system. Poliomyelitis viruses carry single stranded, RNA genome and a protein capsid; with each serotype have capsid proteins with miner differences.

Whereas most people may not realised they are infected, there is a small number who will have symptoms which include: a fever, sore throat and headaches. This is usually 95% of the infections, with viral replication limited to occurring in the pharynx. The small proportion in which the virus reaches their central nervous system will experience symptoms such as a high temperature, stiff neck and muscle pain. This is called non-paralytic poliomyelitis. An even smaller percentage of people affected endure paralysis, muscle cramps and weakness due to the motor neurones being invaded and destroyed by the process of intracellular replication of the virus. This is known as paralytic poliomyelitis. If the virus then goes onto affecting the brain stem, it can effect breathing and swallowing. This is due to viral destruction of bulbar cells, which is the cause of respiratory paralysis resulting in death and is known as bulbar poliomyelitis.

With no specific drugs available, treatments consisted of supportive care and in cases with respiratory muscle paralysis, respiration support. After having any form of poliomyelitis, some symptoms may return either many years or even decades after the original infection. Post-polio syndrome presents clinically with breathing and swallowing problems, muscle loss and also muscle pain and fatigue. Often it can be hard to diagnose as symptoms may develop gradually and so tests include a full blood count, creatine kinase and thyroid function, in order to rule out other ideas.

Poliomyelitis public fear was heightened and propelled research into a safe and effective vaccine after the epidemic in 1952 which had 57,628 polio cases were reported, with more than 21,000 paralytic cases. This was one of the highest levels recorded in the United States.

Previous to Salk's work, the only success in regards to poliomyelitis was in 1948 where all three serotypes of poliomyelitis had been identified, research which had been initiated and funded by the National Foundation for Infantile Paralysis, using cross neutralisation experiments in monkeys. On the other hand, this method was slow and expensive and so Salk was inspired by a new technique found in 1949 and used by Enders, Weller and Robbins who managed to cultivate the Lansing strain of poliomyelitis in non-nervous human tissues. The new method had great potential in fast and cheap cultivating of strain types. This then paved the way for the development of a vaccine, and in 1951 Salk developed a method to cultivate poliomyelitis with the aim to produce a high quantity of the inactivated poliomyelitis vaccine. In order to do this, Salk used monkey kidney tissue and inactivated the virus using formalin. The vaccine works to provide immunoglobulin G-mediated immunity in the bloodstream which prevents the infection progressing to the neurones. The inactivated poliomyelitis vaccine, administered by a trained health worker, is given by intramuscular or intradermal injection. Initially, Salk completed successful tests on animals but he then progressed to injecting his vaccine into children in homes for the physically and mentally disabled. In 1954, Salk's vaccine had the field test approved and so around 1.3 million schoolchildren participated in the trail. This would be one of the largest ever vaccine trails directed by Thomas Francis Jr. Within this randomised, double-blinded test, children were randomly assigned to either the control or vaccine group. By 1955, the results of the extensive trails proved that the vaccine was significantly effective and was licensed in the United States. Studies had shown that Salk's vaccine was between 60% to 70% effective against type 1 poliomyelitis and 90% in regards to both type 2 and 3 poliomyelitis. However shorty after becoming widely available, several cases of paralysis were reported in recipients. After investigation, it was discovered that vaccines from one manufacturer, Cutter Company, had the active virus still present. Consequently, various changes were made to address the problems including new filtration steps put in place which involved improvement to the process to remove aggregated and poorly inactivated virus particles. As well as this, manufacturers were to test larger samples of each vaccine lot and lengthen the time treated with formaldehyde. Even though the vaccine triggers a rapid, efficient protective immune response, there is a slight disadvantage with the fact that it induces low levels of immunity within the intestines. This means that when infected with wild poliomyelitis, the virus is still able to replicate and be excreted in faeces, risking contamination and circulation of the disease.

Despite the injected vaccine being sufficient in protection, in 1961 an oral form of vaccine was developed by Albert Sabin with monovalent, bivalent and trivalent forms offered to protect against all types. Sabin is still considered to be Salk's greatest competitor. As opposed to Salk's injection, the oral poliovirus vaccine is composed of live attenuated poliomyelitis. Using both in different combinations, poliomyelitis has been successfully controlled and in some cases eradicated in certain areas. After vaccination, individuals develop antibodies for all three types of the poliomyelitis virus. Within the UK, poliomyelitis vaccination is offered by the NHS as part of the routine childhood vaccination programme. Due to vaccination programmes, the World Health Organisation has declared areas polio-free such as Europe, the Americas and the western Pacific region. However, type one poliomyelitis still remains a significant issue in Pakistan and Afghanistan.

In recent years, although nearly eradicating poliomyelitis, the routine of using solely oral vaccination is no longer recommended. With the oral vaccination, the live poliomyelitis particles are excreted by recipients of the vaccine, which used to help spread immunity in the unvaccinated population. But despite this, in rare occasions, the vaccine virus has mutated during replication and has regained its ability to cause the symptoms associated with

poliomyelitis. This suggests that oral vaccination has lost effectiveness in providing herd immunity. This is not the case with Salk’s vaccination, showing Salk had a bigger contribution in providing protection from poliomyelitis.

In conclusion, Salk’s work producing the poliomyelitis vaccine has enabled a world wide initiative for national immunisation programmes, making significant progress in many developing countries. More than one thousand children a day worldwide were paralysed from poliomyelitis in 1988. Since, within two hundred countries, 2.5 billion children have been vaccinated. Global incidence of poliomyelitis decreased by 99% and furthermore, the last case of type two poliomyelitis was reported in 1999, with the declaration of its eradication in 2015. Equally successful, is that no case of type three poliomyelitis has been detected since 2012. Therefore, Salk is deserving of the recognition for his contribution on tackling one of the greatest public health diseases that is poliomyelitis.