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Global Initiative to Eradicate Polio

The Global Polio Eradication Initiative, a program organized by the World Health Organization (WHO), Rotary International (RI), the US Centers for Disease Control and Prevention (CDC), and the United Nations Children's Fund (UNICEF), is a world-wide effort to eliminate the number of reported cases associated with the poliovirus. Of those who are infected, about 90% are asymptomatic; they are carriers of the disease, but show no symptoms of infection. However, the other 10% experience asymmetric paralysis, usually in the arms or legs. The program initiated in 1988 and significant improvement has been made since then; due to mass vaccination campaigns, the number of reported polio cases declined from 350,000 in 1988 to 223 by January 2012.[3,10] The awareness of polio prevention has improved greatly in developing countries and the distribution of these vaccines have prevented roughly 10 million cases of paralytic polio and 500,000 deaths since 1988.[9] Although these numbers are promising, there are three countries where polio is still endemic: Afghanistan, Pakistan, and Nigeria.[3]

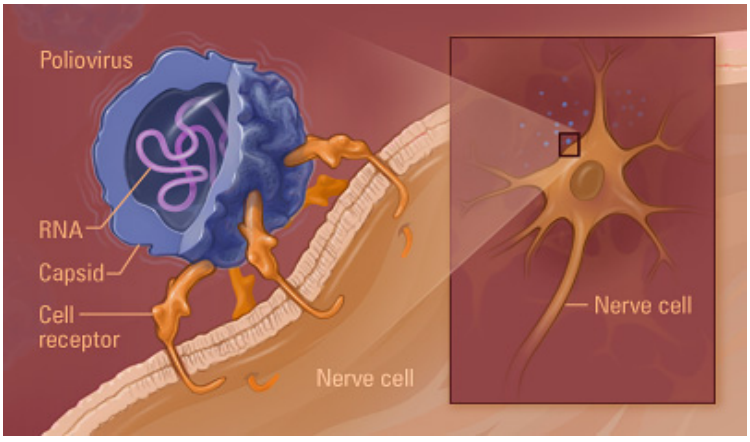

Figure 1: The structure of the poliovirus [5]

Polio (poliomyelitis), *poliós* meaning "grey" and *myelós* meaning "marrow" in Greek, is a highly infectious disease caused by the poliovirus that enters the gray matter of the spinal cord that is responsible for muscle movement.[11] Figure 1 shows the structure of the poliovirus.

Like other viruses, the poliovirus is composed of a capsid made from proteins, virulent RNA, and cell receptors that attach to the host, the nerve cell.[4] In the most common case, aside from being asymptomatic, the virus infects nerve cells and destroys motor neuron ganglia, eventually causing paralysis.[11] Figure 2 shows the life cycle for a poliovirus.[6] In the illustration, the poliovirus, transmitted from fecal particles or saliva of an infected host, attaches to the receptors of the nerve cell via the bloodstream. The capsid breaks open, releasing its genetic material into the cell for replication. More polioviruses form and the nerve cell bursts, or lyses, releasing the replicated poliovirus into the bloodstream. There are three types of poliovirus that can be identified based on their capsid protein: type 1, type 2, and type 3; type 1 is the most virulent and common among patients.[11] Polio is transmitted via fecal-oral or oral-oral route. The fecal-oral route is where fecal particles of an infected patient are introduced into the oral cavity of another; oral-oral route involves the transmission through the respiratory secretion of saliva.[2,7] There is no cure for the disease, but there are vaccines that reduce the risk of contracting the poliovirus.

According to the Global Polio Eradication Initiative website, there are currently 5 vaccines available to the public: oral polio vaccines (OPV), monovalent oral polio vaccines (mOPV1 and mOPV3), bivalent oral polio vaccine (bOPV), and inactivated polio vaccine (IPV).[3,13]

Oral Polio Vaccine (OPV)

The first OPV used was in February 1950; virologist Hilary Koprowski developed it. However, she was not the only one producing the attenuated virus. In 1952, Albert Sabin developed another live OPV and the two, along with other notable researchers, were in competition for a license. In 1958, Sabin's vaccine was selected by the US National Institute of Health and licensed in 1962 as the only OPV to be used worldwide.[12] Sabin's vaccine proved to

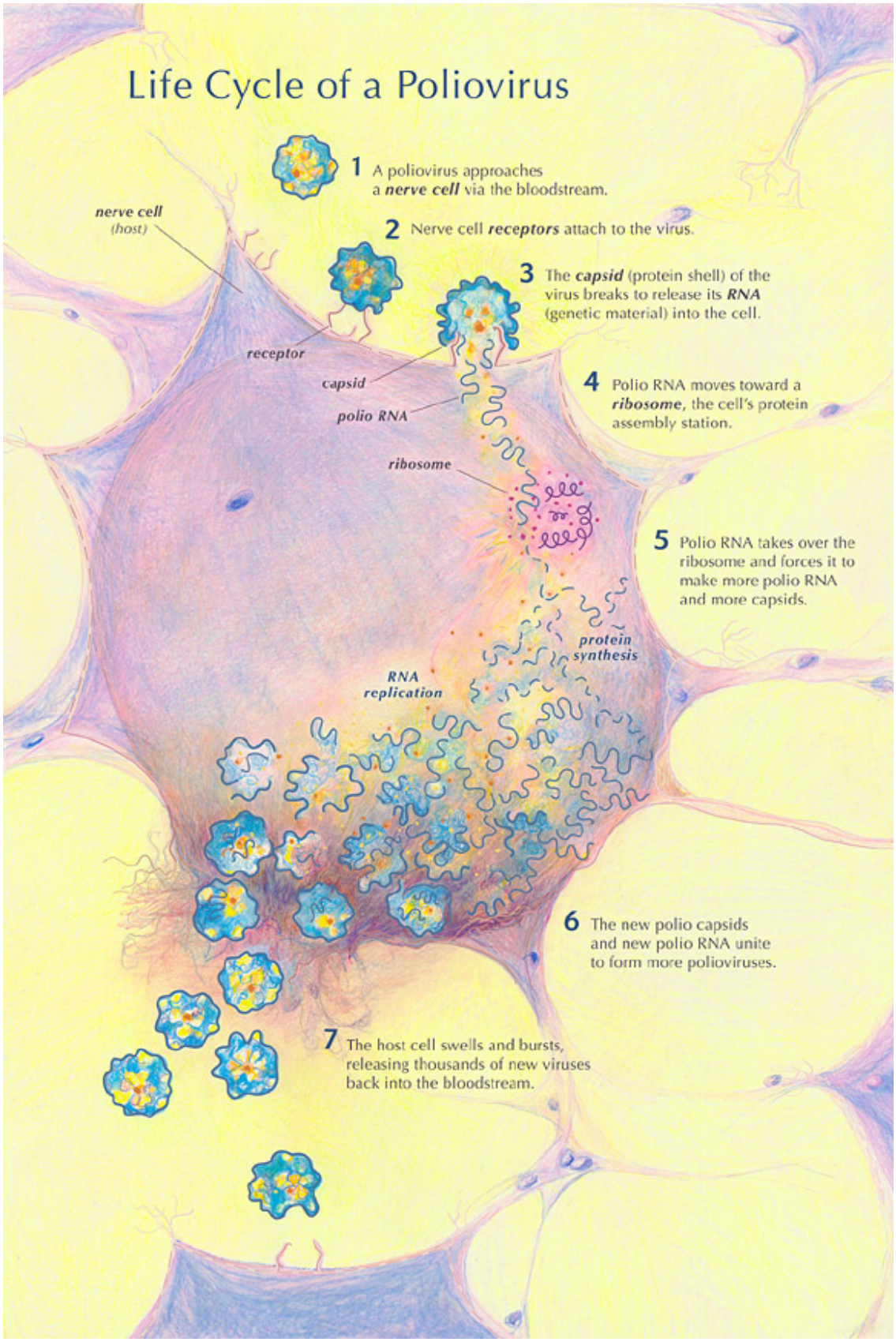

Figure 2: The life cycle of a poliovirus [5]

be efficient; the virus strain replicates only in the intestinal tract, the primary site of wild poliovirus infection and replication. A single dose of Sabin's OPV has proven to be effective for immunity against all three serotypes of the poliovirus for about 50% of the recipients and for 95% of the patients with three doses.[1]

To develop polio vaccines from the live poliovirus, the RNA molecule must be mutated such that that the vaccine will not cause infection, but trigger development of antibodies that protect the patient from paralytic polio. Mutation of the RNA molecule can be achieved through three types: insertion, deletion, and substitution. In Sabin's vaccines, there are 57, 2, and 10 nucleotide substitutions from type 1, 2, and 3 poliovirus, respectively. The main factor present in all three types of Sabin's vaccine is the mutation located in the virus's internal ribosomal entry site (IRES) that reduces the ability of poliovirus to translate its RNA template within the host cell. This disrupts the cycle of poliovirus from synthesizing the protein for replication. The monovalent vaccines for type 1 and type 2 were licensed in 1961. In 1962, a monovalent vaccine for type 3 was licensed. Finally, Sabin's trivalent vaccine, immunization against all three antigens, was licensed in 1963 and is the most commonly used OPV in mass vaccination campaigns throughout the world.[13]

In terms of administering the OPV, the World Health Organization (WHO) recommends that the first dose of the trivalent vaccine should be given at birth and then additional doses at least four weeks apart. It is not harmful to consume multiple doses of the polio vaccine during immunization rounds; the more vaccine, the more one is protected against polio. For developing countries, children often take more than three doses of the vaccine. Malnutrition and poor health can delay the vaccine process in which the child's immune system slowly develops antibodies that are resistant to the poliovirus. According to the Global Polio Eradication Initiative, the

average price for a vaccine in 2012 was US $0.127. Since 2010, the price of an OPV has decreased.[10] OPV is recommended in regions with higher incidence of polio. Since the OPV contains live poliovirus, transportation distance is limited, especially in hot and remote areas. Using an attenuated form of the live poliovirus in OPV establishes a lifetime protection against polio.

Inactivated Polio Vaccine (IPV)

The inactivated polio vaccine is mainly used in the US and other countries where the wild poliovirus is rare. Joseph Salk at the University of Pittsburgh developed the first IPV in 1952. Salk grew he three strains (or types) of the poliovirus in kidney tissue of monkeys; afterwards, the strains are inactivated by formalin, commonly known as formaldehyde. Inactivation becomes apparent in that the poliovirus particles are destroyed and cannot replicate, but the capsid proteins are still intact. Unlike Sabin's OPV, Salk's IPV requires injection via syringe. Immunoglobulin G, IgG, the main antibody present in the bloodstream and extracellular fluid, recognizes the foreign capsid proteins and evokes an immune response to prevent polio infection in the blood and in motor neurons. In 1955, Salk's vaccine was licensed; after a field test, it proved to be 60-70% efficient against PV1, over 90% effective against PV2 and PV3, and 94% against bulbar polio, a rare form of paralytic polio where the virus invades and destroys nerve cells within the bulbar region of the brain stem.[1,12]

The IPV vaccine continued to develop during Salk's career. A more potent IPV that evokes a larger response at lower concentration of the virus was developed in 1987. It is recommended that the doses should be given shortly after birth around 1-2 months, 4 months, 6-18 months, and a booster vaccination right before entering school (4-6 years of age). After Salk's death in 1995, a pentavalent vaccine composed of immunizations against polio, diphtheria,

tetanus, and acellular pertussis, and hepatitis B was approved for use in the US in 2002. Similar to OPV, the duration of immunity appears to provide protection for many years after a complete series of IPV; for any reason an adult would need additional vaccines are such that one is traveling to a polio-endemic area, working with specimens containing the poliovirus, or treating patients who could have polio. The cost for IPV is more than ten times that of OPV, roughly US $2 per dose.[10]

One of the major concerns of OPV is the ability to revert to a pathogenic form that can cause paralysis. VAPP, or vaccine-associated paralytic poliomyelitis, is very rare and is due to a mutation in the live vaccine. The rate of reported VAPP cases is 1 in every 750,000 recipients. OPV was discontinued in the United States in 2000 and the United Kingdom in 2004, but it is still used across the globe. Since wild polio has diminished greatly since the mid-1950s, many nations are transitioning to IPV because reversion of a mutagenic strain is not possible.[13]

The Global Polio Eradication Initiative has become one of the greatest public-health achievements in the world. Since its establishment in 1988, all but Nigeria, Afghanistan, Pakistan, remain endemic as wild poliovirus continues to infect these areas. Polio was eradicated in the Americas by 1994. 36 countries in the Western Pacific, including China and Australia, were officially eradicated of polio in 2002. Recently, there have been no reported cases of polio in India that was removed from the endemic list by WHO in February 2012. As of September 2013, there has been an outbreak of polio along the horn of Africa where over two-thirds of the cases are in countries that were previously polio-free.[12] The combined case numbers in Afghanistan, Nigeria, and Pakistan have decreased by 40% from 2012. Poliovirus has been detected in sewage in Israel, and samples have tested positive in the West Bank and the Gaza Strip.[3] Although significant progress has been made since the establishment of the initiative,

WHO, UNCEF, CDC and RI continue to remain vigilant through mass vaccination campaigns, public awareness, and effective monitoring.

Polio vaccine production has improved living conditions in many developing countries. Since the establishment of a global initiative, 200 countries have joined in cooperation as well as 20 million volunteers to vaccinate 2.5 billion children worldwide. US$ 8 billion has been invested due to the growing concerns of paralytic polio and deaths associated with the disease.[3] The most important factor that has greatly influenced this achievement is communication; however, current progress has been difficult. After a recent anti-polio drive in Pakistan, 47,099 children have been missed for polio vaccines due to parental refusal. Many parents in Pakistan are convinced that polio vaccines cause sterility in adulthood.[8] As for the United States, polio has been included in the new vaccine criteria required for immigration.[5]

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