

A View from Above of the Global Poliomyelitis Situation: Pakistan Strategies for Polio Eradication

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Abstract

Throughout history, humanity has encountered several catastrophes, such as natural disasters and the emergence of countless contagious diseases. Poliomyelitis is one such disease. The initial instances of the sickness emerged in the 1940s, prompting health authorities and specialists to develop a vaccine to enhance children's resistance to the virus. Subsequently, polio workers worldwide are diligently endeavouring to raise awareness regarding the crucial significance of polio vaccination, particularly in the tribal regions of Pakistan. This is because the inhabitants of these areas are predominantly underprivileged and uneducated, resulting in their reluctance to vaccinate their children due to apprehensions about safety, as well as religious and misconceptions about the vaccine. The objective of these efforts is to ensure that every kid in Pakistan and Afghanistan receives appropriate immunization in order to halt the spread of the virus by the year 2025.

Keywords: Polio, Strategies, Vaccine, Pakistan.

Introduction

Poliomyelitis, an acute disease affecting the central nervous system, originated in Europe and the United States at the beginning of the twentieth century (Racaniello, 2006). The World Health Organization (WHO) made a commitment in 1998 to eliminate poliomyelitis worldwide by the year 2000 (Kabir & Afzal, 2016). According to current assessments, Pakistan, Nigeria, and Afghanistan are classified as polio-endemic countries (Bandyopadhyay, 2015). Poliomyelitis is a lethal viral infection produced by three serotypes of the poliovirus, mostly occurring in children under 5 years old and resulting in profound muscle paralysis or possibly mortality. The transmission of the virus to healthy individuals occurs when they come into contact with water or food that has been contaminated with the faecal matter of the infectious person. Although there is now no known cure for the condition, it can be averted by the successful immunization of youngsters against the virus. The global strategy to eliminate poliomyelitis began in the 1970s with the main objective of eliminating the poliovirus from all regions of the world until 2000 (Mehndiratta et al., 2014). Thus, Global immunization day was observed to interrupt the transmission chain in many industrialised countries, as the whole population under the age of 5 received Immunization, regardless of prior vaccination status. This collaborative endeavour yielded positive results, as the majority of countries worldwide successfully eliminated this virus from their territories completely by the year 2012. However, Pakistan, Nigeria, and Afghanistan are still facing challenges in altogether eliminating this virus (Bandyopadhyay et al., 2015) The present analysis centres on the eradication effort of

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polio in Pakistan and underscores the significant challenges encountered in the successful elimination of polio from the country.

From Greece, the term poliomyelitis originates, where "polio" refers to "grey" and "myelon" means "marrow" (Mehndiratta et al., 2014). The disease is caused by a highly contagious human Enterovirus (genus) of the picornaviridae family, namely poliovirus, which includes serotypes 1, 2, and 3 (Hussain, 2016; Kabir & Afzal, 2016; Nadeem, 2016). All three serotypes of poliovirus are distinct from each other and induce paralytic illnesses (Racaniello, 2006).

Forms of Poliomyelitis Virus

Poliomyelitis can be classified into three types: S poliomyelitis, Bulbar poliomyelitis (2%), and Bulbospinal poliomyelitis (up to 19% according to Nadeem, 2016).

Polio virus structure consists of a single-stranded (+)-strand RNA with a length of 700 nucleotides and a diameter of 25-30 nm. The capsid of the virus consists of 60 protomers, in which each protomer contains four virion (VP1, VP2, VP3, and VP4). Mendelsohn et al. (1989), Racaniello (2006), and Mehndiratta et al. (2014) are cited in the text. CD155 receptors are present in all three serotypes (Mendelsohn et al., 1989). Three extracellular domains are present in CD155: a V-type domain located distant to the membrane (for poliovirus attachment) and two C2-type domains (Koike, 1990).

Symptoms

Asymptomatic is the prevailing condition in most individuals afflicted with this virus (Mehndiratta et al., 2014). While other symptoms including influenza-like illness, gastroenteritis, severe muscle spasm of the back, lower limbs and neck, moderate respiratory tract infection (Mehndiratta et al., 2014). Paralytic poliomyelitis, the most severe manifestation of poliomyelitis, affects less than 1% of patients and is characterised by intense episodes of pain in the lower limbs and back (Bone, 2006).

Effects on Human Body

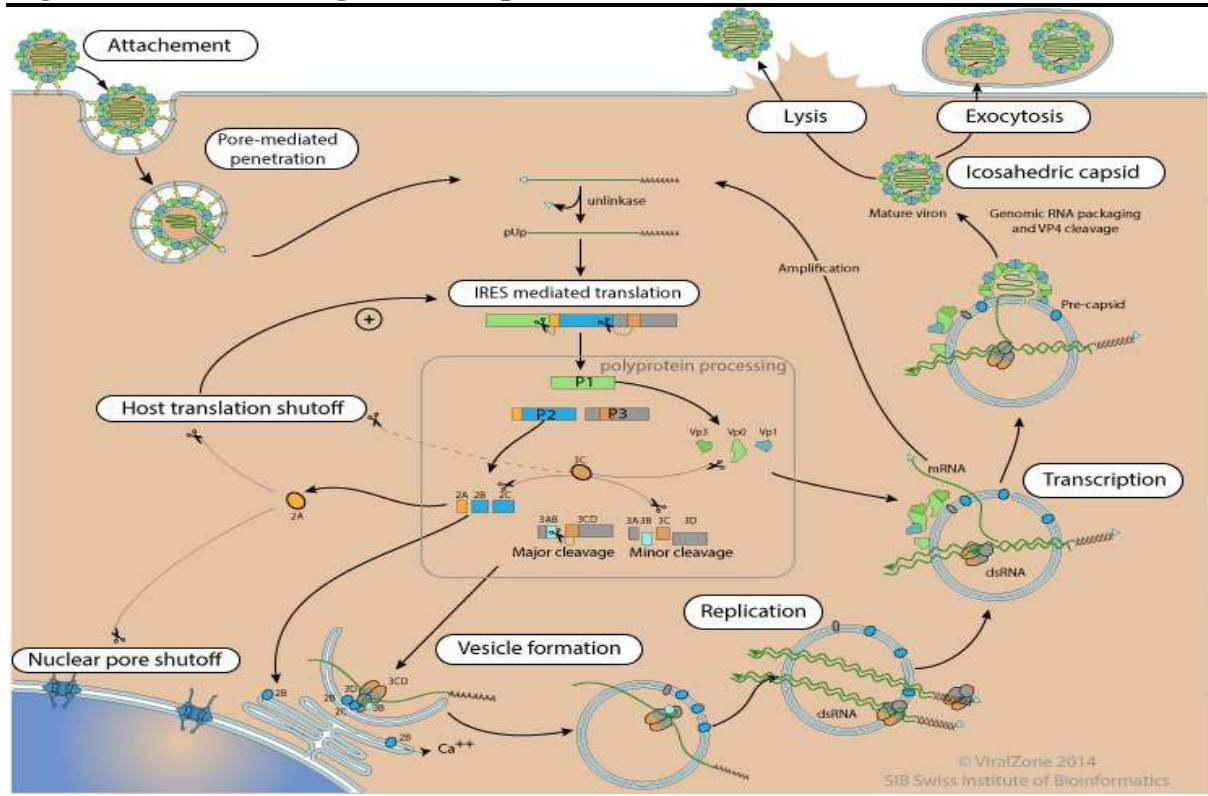
The human nervous system may be specifically targeted by poliovirus (Kabir & Afzal, 2016).

Transmission of Mode

After multiplying in the gut, poliovirus is transferred horizontally through the fecal-oral channel, oral-oral route, and, in rare instances, water or milk (Hussain, 2016). Furthermore, it can be spread through the saliva of an individual who is sick (Kabir & Afzal, 2016). Impaired sanitation greatly accelerates the transmission of poliovirus, particularly among vulnerable populations. The process of propagation begins during the summer season in temperate countries (Mehndiratta et al., 2014).

Action Mechanism

Poliovirus invades human cells by attaching to an immunoglobulin-like receptor, CD155 (sometimes referred to as the poliovirus receptor or PVR), located on the extracellular surface of the cells. The interaction between poliovirus and CD155 induces a permanent alteration in the architecture of the viral particle, which is essential for viral entrance.

Figure 1: Schematic diagram of the polio virus action mechanism

Background of Epidemiology

Poliovirus has been scientifically linked to humans for ages, but the initial clinical account of poliomyelitis was documented by British physician Michael Underwood in 1789, characterising it as a lower extremity sickness.

Lansteiner and Popper identified the etiological agent of poliovirus in 1908 (Monto, 1999). European documentation of the early epidemic of polio dates back to the 19th century, whereas the earliest reported outbreak of polio occurred in the United States in 1843. March of Dimes, formerly known as the National Foundation for Infantile Paralysis, was founded in 1938 to offer comprehensive treatment to patients and provide financial support for research (De Jesus, 2007). In 1988, the World Health Organization (WHO) made the decision to eliminate Polio from planet Earth by the year 2000. They successfully accomplished this goal with just a few deviations.

The poliovirus is predominant in Pakistan and Afghanistan as the sole reservoirs. The Extended Programmes on Immunization (EPI) have effectively combated polio. The numbers of polio cases decreased from 198 in 2011 to a mere 54 in 2015. The objective of the EPI was to effectively eliminate polio from Pakistan on or before 2018 (Nadeem, 2016).

Polio Program Extension

In 1978, the extended programmes on Immunization were initiated in Pakistan (Hussain, 2016). The neonates were scheduled to receive three doses of OPV at 6, 10, and 14 weeks of age. Later, in 1994, a birth dose of the vaccine was included into the polio eradication effort in Pakistan (Murakami, 2014).

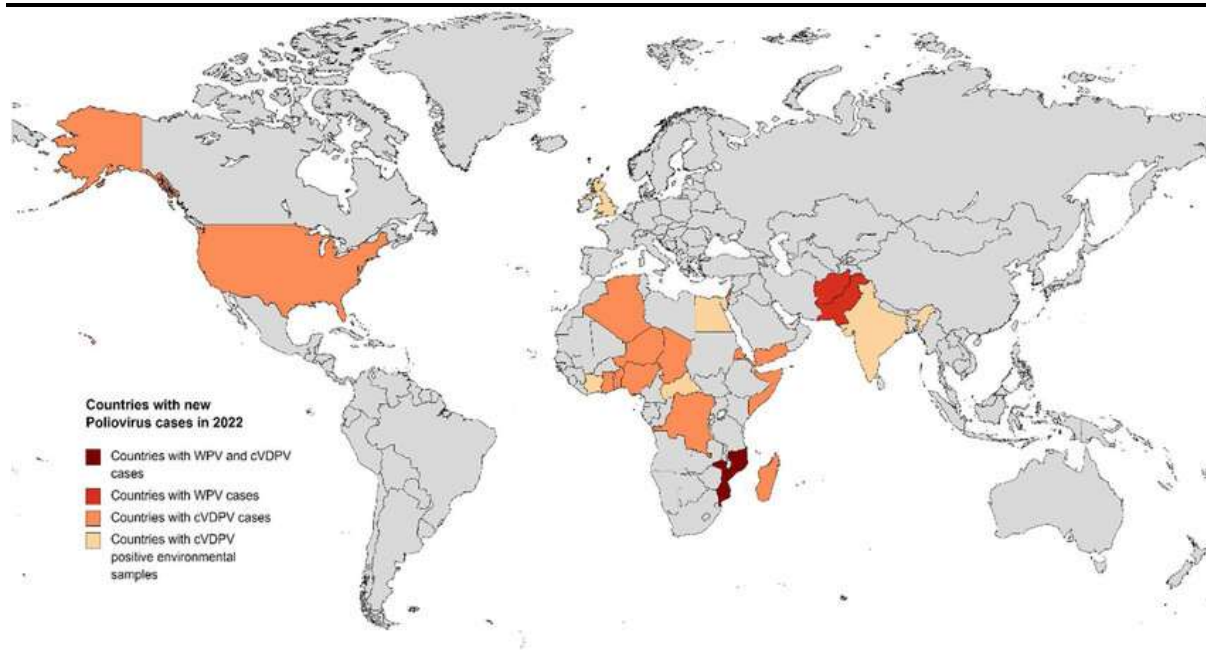
Global Polio Eradication Program (GPEI) and Pakistan

The incidence of poliovirus cases saw a precipitous drop from 350,000 in 1988 to 407 in 2013, representing a reduction of around 99%. The continental regions of America, Europe, South

East Asia, and the Western Pacific were officially declared free of polio until the end of the twentieth century (Macklin, 2020). Since its inception in 1988, the Global Polio Eradication Initiative has significantly reduced global cases by a large factor.

Despite the limited number of 54 cases documented in 2016, Pakistan appeared to be making significant strides in its progress through this effort. Nevertheless, they failed to achieve their objective and the instances resurfaced in 2017 (Talan et al., 2014).

Figure 2: Schematic diagram of the countries with Polio virus 2022



Polio Virus in Pakistan

Pakistan continues to face challenging circumstances in its efforts to combat the polio virus. To have a deeper understanding of the challenges in eliminating the virus from Pakistan, it is beneficial to examine epidemiology case analyses (Kabir & Afzal, 2016). The following table presents the statistical data on the reported cases of polio over the past 5 years. The predominant diseases affecting Pakistan at now are wild poliovirus type 1 and vaccine-derived poliovirus type 2 (Kabir & Afzal, 2016).

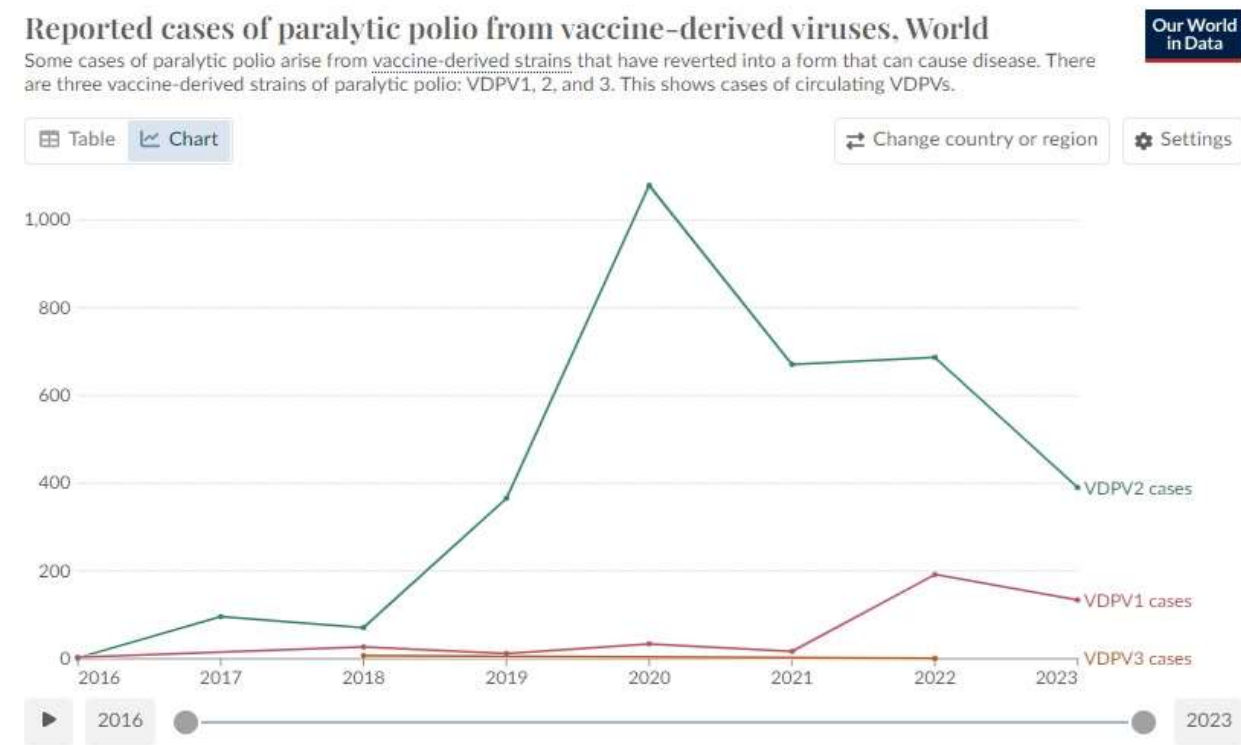
Table 1: WPV Polio Cases across Pakistan's Provinces (Endpolio, 2020)

Province	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Punjab	2	0	1	0	12	14	0	0	0	29
KPK	33	10	1	8	93	22	0	20	4	191
Sindh	12	8	2	8	30	22	0	0	2	82
Baluchistan	7	2	3	3	12	26	1	0	0	54
Azad Jammu Kashmir	0	0	0	0	0	0	0	0	0	0
Gilgit Baltistan	0	0	1	0	0	0	0	0	0	1
ICT	0	0	0	0	0	0	0	0	0	0
Total	54	20	8	12	147	84	1	20	6	352

Table 2: cVDPV2 Polio Cases across Pakistan Province (Endpolio, 2020)

Province	Year									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Punjab	0	0	0	0	1	25	1	0	0	27
KPK	2	0	0	0	16	42	1	0	0	61
Sindh	0	0	0	0	0	45	2	0	0	47
Baluchistan	0	1	0	0	0	23	4	0	0	28
Azad Jammu Kashmir	0	0	0	0	0	0	0	0	0	0
Gilgit Baltistan	0	0	0	0	4	0	0	0	0	4
ICT	0	0	0	0	1	0	0	0	0	1
Total	2	1	0	0	22	135	8	0	0	168

At the inception of the Global Polio Eradication Initiative in 1988, the virus was causing an annual disability in around 350,000 children. Through the year 2016, the global incidence of any variant of polio had been reduced to 34 cases. Nevertheless, it is anticipated that the number of instances will escalate much more in the upcoming months in the year 2020. Thus far this year, around 200 instances of wild polio have been detected, out of which over 600 are cases of the vaccine-derived form of the disease.

Figure 2: Decline in the Number of Polio Cases over the Years

Vaccine Development

The occurrence of numerous paralytic poliomyelitis outbreaks in North America during the 1950s captured the interest of health authorities. The national foundation for infantile paralysis

allocated millions of dollars exclusively for the purpose of developing a vaccine to prevent the transmission of the poliovirus.

The cultivation of Lansing strains of poliomyelitis in human embryonic tissue by Robbins, Enders, and Weller resulted in the creation of the formalin-inactivated poliovirus vaccine (IPV) in 1953 by Jonas Salk, which was administered as an injection. Additionally, Albert Sabin developed live attenuated polio vaccines (OPV) in 1956, which were given as oral drops (Pearce, 2004; Wilton, 2014).

An evident decrease in the transmission and occurrence of the virus in the United States, from around 20,000 cases annually in the 1950s to less than 1,000 cases by the 1960s, can be attributed to the introduction of the inactivated poliovirus vaccine (IPV) (Orenstein, 2015). Yet, in less developed nations, the live-attenuated oral poliovirus vaccine (OPV) remains the most often used vaccination because of its cost-effectiveness, simplicity of delivery, and relatively more potent stimulation of intestinal immunity compared to the IPV (Hussain, 2016). Polio elimination efforts commenced in Pakistan in 1994 (Nathanson, 1982). The annual financial outlay of Pakistan on the polio vaccination amounts to 157,318,761 million PKR (Naqvi, 2018). The vaccines available in Pakistan are sourced from Belgium and Indonesia, produced by Biopharma pharmaceuticals, and undergo validation by W.H.O. Subsequently, UNICEF procures these vaccines. Vaccine cold chains have been securely maintained and stored within a temperature range of 0°C to -20°C. (Naqvi et al., 2018).

The IPV vaccination effectively decreased the incidence ratio from 13.9 cases per 100,000 in 1954 to 0.5 cases per 100,000 in 1961. Meanwhile, the researchers persisted in their efforts to create a vaccine that would effectively stimulate a more robust gastrointestinal immunity compared to intraparenetal poliovirus (IPV). In 1963, they successfully synthesized a trivalent oral poliovirus vaccine, comprising live attenuated viruses (Baicus, 2012).

OPV Introduction

Preventive vaccination (OPV) is highly efficient in decreasing poliomyelitis caused by wild type polioviruses. Administration of the oral poliovirus vaccine stimulates the immune system to produce antibodies against poliovirus type 1, 2, and 3. Over a period of 4-6 weeks, the live virus remains in the intestine of recipients, causing the production of both mucosal and serum anti-poliovirus antibodies that are capable of eliminating wild poliovirus. However, there is a dilemma linked to OPV, namely that it can lead to the production of vaccine-derived poliovirus, which are genetically altered strains (Nadeem, 2016). Clinical trials of oral contraceptive (OPV) demonstrated highly encouraging outcomes and effectively substituted intraperitoneal (IPV) in nearly all countries worldwide, with the exception of Finland, Sweden, and the Netherlands (Nadeem, 2016). While OPV is believed to be responsible for causing Vaccine Associated Paralytic Poliomyelitis in 8 to 10 OPV immunized patients in the US annually, the overall therapeutic effectiveness of OPV is far greater than that of IPV. In other words, the benefits of OPV outweigh the risk of VAPP, which is caused by the conversion of the attenuated genome back to the virulent one. This conversion often occurs when the immune system is severely weakened due to malnutrition or other abnormalities. Although the United States of America was liberated from the wild poliovirus circulation in 1979, the risk of contracting VAPP could not be disregarded. Therefore, researchers endeavoured to develop a safer vaccine with superior efficacy and safety profile compared to OPV. In the 1980s, they successfully produced "enhanced potency IPV (E-IPV)," which quickly replaced the trivalent OPV in routine pediatric immunization programs in most developed countries (The Current tours Pakistan's Polio Lab, 2019). IPV is a costly yet very efficient intervention. The IPV vaccine has been in use for 15 years in the USA, while OPV is predominantly used in lower-income countries like Pakistan. Therefore, it is crucial to cut the price of the IPV vaccine to make it affordable for middle-class countries (The Current tours Pakistan's Polio Lab, 2019). On August 24, 2015, Pakistan

introduced IPV into its routine immunization schedule, marking another milestone towards a future free from polio. The ceremony was led by Miss Saira Afzal Tarar, Minister of State, Ministry of Supervision and Coordination of National Health Services, and was attended by representatives from WHO, UNICEF, GAVI, USAID, and the UK Department. (2019) The Current tours Pakistan's Polio Lab. A significant milestone, the introduction of the inactivated polio vaccine (IPV) in Pakistan will benefit more than 6 million children each year and will be given in conjunction with other life-saving immunizations. In April 2016, a worldwide directive was implemented to remove live attenuated polio vaccine from the immunization program, after the worldwide confirmation of wild poliovirus type 2 (WPV-2) eradication (Davis & Jackson, 2021).

Vaccine Comparison

Figure 3: Desirable specifications sought in an apolio vaccine, including a comparison between the oral and inactivated polio vaccines (Tariq et al., 2020)

Attribute	'Ideal vaccine'	OPV	IPV
Route of administration	Noninjection	Oral	im. injection
Thermo stability	Heat and freeze stable	Heat sensitive	Heat and freeze sensitive
Humoral immunogenicity	Good	Good	Good
Intestinal immunogenicity	Good	Good	Poor
Cost	<US\$0.10/dose (similar to current OPV cost)	~US\$0.15/dose (UNICEF prices US\$0.10–0.20)	~US\$1/dose
Safe production	Widespread and low risk	Widespread and low risk	Only in select countries, risk of reintroduction of WPV from manufacturing facilities
Safety	No safety issues	VAPP, VDPVs	No safety issues
Schedule/duration of protection	1 dose	Multiple doses	At least one dose in combination schedules, four to five doses in IPV only schedules
Method of administration	Routine immunization and SIAs	Routine immunization and SIAs	Routine immunization and small-scale SIAs
Waste management	No risk	No risk	Sharps disposal
Cold storage space	Small	Small	Small (<5–7% of total volume)

im: Intramuscular; IPV: Inactivated polio vaccine; OPV: Oral polio vaccine; SIA: Supplemental immunization activity; VAPP: Vaccine-associated paralytic poliomyelitis; VDPV: Vaccine-derived poliovirus; WPV: Wild polio virus.

Challenges for Polio Eradication in Pakistan

Following the commencement of the polio eradication programmes, health authorities encountered several obstacles that hindered the successful achievement of the goal of eradicating polio. In the early phases of the programme, the failure of Immunization campaigns can be attributed to illiteracy, religious misunderstandings (vaccine hesitancy), disputes, insecurities, terrorist attacks, and inadequate vaccine quality. The civil violence stood as a significant obstacle to the complete elimination of poliovirus. Additional significant challenges faced by developing countries included inadequate management techniques, ineffective health communication, and insufficient documentation of vaccine resources at the district and provincial levels. Traditional leaders failed to provide education to the people, and certain religious problems were also widespread in the society, particularly in Northern Nigeria and Pakistan. According to the World Health Organization (WHO), Pakistan accounts for 80% of the global documented cases of polio.

Barriers in Polio Vaccination

In 2012, the Taliban in the FATA and KP region prohibited vaccinations, resulting in 360000 children being deprived of vaccinations for two years. Additionally, the Taliban terrorist attack on the vaccination teams led to the deaths of many team members, creating a shortage of qualified personnel that is challenging to recruit. The issue of eradicating polio is particularly

severe among the internally displaced persons (IDPs) who have relocated to other parts of KP. Reference: Hussain, 2016. Following the assassination of Osama Bin Laden in Abbottabad, the religious clerics and militant Taliban demonstrated that Americans had identified Osama in connection with the counterfeit hepatitis-B vaccine. They even procured polio vaccine using CIA monies to prevent its usage. Furthermore, this had a significant effect on the polio elimination effort in FATA and KP. The vaccination team in that region suffered significant damage, and a poll indicated that a mere 25% of the local population had faith in the indispensability of the polio vaccination. Reference: Hussain, 2016. Factors contributing to Pakistan's current status as a polio hotspot largely include illiteracy, religious misunderstandings regarding vaccinations, insecurity, terrorist attacks, starvation, negative attitudes, and inadequate vaccine quality (Nadeem, 2016). According to Nadeem (2016), The requirement for supplementary immunization activities (SIAs) to cover all regions of the country and the significant variations in population density within the country pose obstacles to the polio eradication.

Countering Challenges in Polio Eradication

According to Davis and Jackson (2021), the National Childhood Vaccine Injury Act of 1986 mandates that vaccinators must distribute a Public Health Service vaccine information brochure to the parents of the child throughout the vaccination administration process. The National Emergency Operations Center (NEOC) has developed a detailed strategy to extend polio eradication efforts throughout the low polio transmission season (January-April) in Pakistan. This strategy focuses on implementing routine immunization programs for OpV to effectively stop the transmission of whole-particle poliovirus (WPV). The objective of NEOC was to minimize any lingering deficiencies in immunity by identifying and administering vaccinations to children who had been consistently neglected. Between January 2014 and October 2015, children under the age of 5 received house-house supplementary immunizations administered mostly monovalent oral poliovirus vaccine type 1 and bivalent type 1 & 3 OPV. Secondary Immunization Activities (SIAs) conducted at designated Immunization stations since November 2014 provided vaccination to 1.7 million children in regions of FATA that have compromised security (Mehndiratta et al., 2014). Pakistan remains one of the two sovereign nations grappling with the issue of ongoing spread of wild poliovirus. The international organizations WHO, UNICEF, and other partners of the Global Polio Eradication Initiative provided assistance to the Pakistani government in attaining polio-free status. Pakistan's polio eradication program has executed a rigorous vaccination campaign schedule that prioritizes operational enhancements to attain herd immunity in the prominent reservoirs of Karachi, KPK, and Quetta Block, while ensuring that the rest of the country remains free from polio. (World Health Organization, 2019; Nadeem, 2016). The authorities have devised strategies to overcome challenges by establishing resource centers in high-risk locales, focusing on nomads and internally displaced persons (IDPs) through permanent transit posts (PTPs), raising awareness in low literate populations through books, conducting seminars with enlightened religious clerics, and organizing health camps in impoverished districts. In 1991, complaints were received regarding the length of public awareness booklets, prompting the simplification of the printed materials.

Future Strategy for Polio Eradication in Pakistan

Regrettably, Pakistan continues to be identified as a country where the poliovirus is present, and the Pakistan government must implement specific essential measures to achieve a Pakistan free from polio. The ultimate objective of the Global Polio Eradication Initiative (GPEI) has always been to vaccinate every child worldwide against the lethal Poliovirus. This ongoing effort has effectively eradicated the virus from most nations, with the exception of two

countries (States, 2016). Presently, the primary objective of GPEI is to eliminate the poliovirus from Pakistan and Afghanistan, which remain the sole countries worldwide that have not yet achieved complete eradication of the virus.

WHO, the GPEI collaboration, and the strategy for 2022-2026

The Global Polio Eradication Initiative (GPEI) is the primary vehicle through which the World Health Organization (WHO) assumes a proactive position in the execution of health and immunization programs, encompassing polio. The Global Pandemic Emergency Initiative (GPEI) is a collaborative effort between national governments and six key partners: the World Health Organization (WHO), Rotary International, the US Centres for Disease Control and Prevention (CDC), the United Nations Children's Fund (UNICEF), Bill & Melinda Gates Foundation, and Gavi, the Vaccine Alliance (GPEI Strategy 2022-2026, 2021).

The GPEI strategy 2022–2026 expands upon the significant insights gained over the past thirty years and outlines the necessary methodologies, tactics, and instruments, specifically tailored to the COVID situation. Key objectives include addressing deficiencies in operations and community involvement in countries with high prevalence of the disease (such as microplanning, ensuring that human resources are socially and programmatically appropriate, creating social maps and alliances, and implementing data-driven, high-level accountability), adapting operational resilience and access negotiation strategies to the changing situation in Afghanistan, and strengthening government ownership and supervision in Pakistan. Significantly featured is the use of the innovative oral polio vaccine type 2 (nOPV2).

Presented below are the primary program areas that are advancing towards eradication in the region.

Immunization

Supplementary Immunization: Mass immunization campaigns, generally referred to as national immunization days (NIDs) or supplementary immunization activities (SIAs), are designed to supplement the regular immunization regimen that a child adheres to from birth. The objective of mass campaigns is to halt the spread of poliovirus by administering the oral polio vaccine to every kid under the age of five, irrespective of their prior immunization status. This serves to identify children who have not participated in previous immunization sessions and to enhance the immunity of those who have already received immunization. By adopting this approach, all children within the most vulnerable age bracket are ensured simultaneous protection against polio, therefore diminishing the capacity of the poliovirus to infect any further children.

Serum immunoglobulins (SIAs) have played a crucial role in the polio programme by effectively reducing poliovirus transmission by over 99.99% worldwide since the start of the global eradication challenge in 1988. In regions where the virus is confirmed or suspected to be continuing in circulation, or where the transmission of SIAs has not reached a sufficient number of children, the initiative implements 'mop-up campaigns' to increase the overall immunity of the population.

Where limited GPEI resources have halted preventative SIAs, integrated multi-antigen campaigns offer a chance to enhance coverage and decrease the number of zero-dose children, who have not received any dose of the polio vaccine, as well as children who are otherwise vulnerable to polio.

Outbreak Response Campaign: Outbreak response campaigns are initiated in regions where the virus is recently identified, with the aim of controlling its transmission. Within a standard epidemic response, it is generally accepted that a minimum of two rounds of vaccination of high quality are necessary to establish sufficient immunity among the population.

Recent appearance of polioviruses originating from vaccines has prompted outbreak reaction in multiple countries in the EMR. Irrespective of the specific kind of poliovirus epidemic, the same approach is taken: implementing vaccination campaigns of paramount quality. The efficacy of these outbreak response campaigns is demonstrated by the successful containment of wild poliovirus type 1 and circulating vaccine-derived poliovirus type 2 outbreaks in Syria in 2015 and 2018, respectively. This achievement serves as evidence of the remarkable efforts made by health workers to address the virus in the face of conflict and significant population displacement. An outbreak of cVDPV3 in Somalia, which caused paralysis in seven infants, was officially declared over in early 2021.

Routine Immunization: All countries must have high routine immunization coverage of children, with the polio vaccine included in national routine immunization regimens, for polio eradication to be achieved. Refining regular vaccination is a fundamental element of the GPEI's strategy for 2022-2026.

Although routine immunization alone is insufficient to eliminate the illness, achieving thorough coverage of routine polio vaccine enhances population immunity, decreases the occurrence of polio, and enables the possibility of eradication. Insufficient maintenance of consistently high immunization coverage results in the accumulation of pockets of unimmunized youngsters, which may facilitate the ongoing transmission and occurrence of poliovirus outbreaks.

To avoid the re-establishment of poliovirus by importations from other countries, the polio programme urges polio-free countries to guarantee high levels of vaccine coverage. This is a specific hazard in the context of population migration across borders, or in locations where certain people are reluctant or unwilling to receive vaccinations, making them more susceptible to contracting vaccine-preventable diseases such as polio.

Focusing strategically on addressing the needs of the most vulnerable children: Immunization serves as the fundamental basis of the primary healthcare system in many regions worldwide, especially in the Eastern Mediterranean region (EMR). It is an inherent entitlement of every individual and one of the most valuable investments in health expenditure. Immunization serves as a crucial point of contact between healthcare providers, parents, and children. For instance, the polio programme, which is frequently responsible for carrying out immunization efforts in less developed countries with limited maternal and child health (EMR) systems, is often the first to discover children who have not had any vaccinations. There exist multiple interconnected and continuous initiatives aimed at ensuring that the most susceptible children receive the necessary immunizations, and the polio programme plays a crucial role in each of these efforts.

The Immunization Agenda 2030: A Global Strategy to Leave No One Behind is a visionary and strategic plan aimed at tackling the obstacles associated with delivering life-saving vaccinations to children worldwide.

Gavi 5.0 is a recently introduced five-year strategy provided by Gavi the Vaccine Alliance. Its primary objective is to allocate dedicated funds towards reaching children who have received zero doses of vaccination.

Containment and Certification

How Polio Containment Works: The Global Commission for the Certification of Eradication of Poliomyelitis (GCC) has previously announced complete elimination of two out of the three forms of poliovirus: wild poliovirus type 2 in September 2015, and wild poliovirus type 3 in October 2019. The sole strain who is still in circulation is wild poliovirus type 1. Following the eradication of each variant of poliovirus, governments are highly advised to either eliminate their poliovirus materials or transfer them to a government-designated poliovirus-essential facility (PEF). Any nation that chooses to keep materials for purposes such

as vaccine manufacturing and crucial research must obtain certification for their specified facilities that are necessary for poliovirus control, in accordance with the GAPIII Containment Certification Scheme (GAPIII-CCS).

Compliance with rigorous biosafety and biosecurity standards in all facilities that handle or store eliminated polioviruses reduces the likelihood of these viruses being discharged into the community. Constraining the number of facilities housing the virus to the lowest possible level significantly decreases the danger and increases the probability of meeting and sustaining global containment requirements.

Working towards Certification: The certification of polio elimination is carried out at a regional level. Certification in each region is contingent upon all nations in the area undergoing certification standard surveillance and demonstrating the absence of wild poliovirus transmission for a minimum of three consecutive years. Among the 22 countries in the EMR, 20 have obtained certification as being free from wild poliovirus. It is in Afghanistan and Pakistan that wild poliovirus type 1 continues to circulate. Global certification has been granted to wild poliovirus strains 2 and 3.

Established in 1995, the Eastern Mediterranean Regional Certification Commission (EM/RCC) has been convening both annually and regularly since its inception. To date, a total of thirty-five meetings have taken place, with the most recent one being held virtually from 1-3 June 2021.

The EM/RCC monitors the advancements made by Member States and determines their certification status based on their capacity to prove the lack of wild poliovirus transmission for a minimum of three consecutive years, considering the implementation of certification standard surveillance and the annual capacity to sustain this monitoring. Importantly, the inclusion of vaccine-derived poliovirus in certification is not currently being considered. All countries, with the exception of the two countries with endemic prevalence, have submitted their fundamental and final national documents for certification. In all instances, the documentation has been approved. Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Occupied Palestinian Territory, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, and Yemen are among the accredited countries.

Contribution Beyond Polio

Polio Leadership in COVID-19 Pandemic Response: Beginning in early 2020, as COVID-19 started to spread throughout the Region, the polio programme took on the role of supporting and, in certain countries, spearheading the pandemic response. The program demonstrated rapid and efficient performance by virtue of its human and organizational capabilities to address critical requirements during a pandemic, including disease surveillance, case management, contact tracking, data management, and communication. Polio workers efficiently utilized their pre-existing expertise to address a novel disease, therefore showcasing their adaptability and significance in addressing wider health concerns. In 2021, the polio workforce demonstrated remarkable dedication, particularly in preparation for the introduction of the COVID-19 vaccine. Through their strategic adaptation to address the epidemic, polio workers have demonstrated their significant contribution to enhancing health systems, particularly in emergency response and crucial immunization efforts.

Rotary Polio Plus: Another method by which polio workers contribute to wider health outcomes is by offering products or services that are not directly associated with polio or immunization. Rotary International, a co-founder of the Global Polio Eradication Initiative (GPEI), has consistently provided financial support for a campaign known as Polio Plus. The monies from Rotary are used towards the purchase and distribution of soap, the organization of health camps, and the financing of water pump installations. Under all circumstances, the

inclusion of vaccination and education regarding the advantages of immunization is an essential component of the 'plus' package. By granting access to well recognized health factors, such as uncontaminated water, proper sanitation, and enhanced nutrition, sustained and significant improvements in health outcomes can be achieved.

Integration and Transition of Polio Functions: As the goal of eliminating polio approaches, measures are being taken to guarantee that as the polio programme leaves nations without polio, the essential health capabilities it has long endorsed be assumed and financed by other WHO programmes and, eventually, by national governments. The objective of the polio transition process is to leverage the groundwork established by the polio programme to construct resilient health systems that provide the necessary health services to communities. Implementing integration among WHO programs is an essential measure towards achieving a lasting shift in polio resources, and is a fundamental aspect of the 2022–2026 GPEI strategy. The process can begin within the context of an outbreak, when teams responsible for responding to the outbreak collaborate with the expanded vaccination program and other partners to enhance crucial immunization efforts in and around the designated outbreak regions. It can also occur as polio assets are included into regular immunization infrastructure, independent of the outbreak situation.

At the regional level, the transition work stream involves the establishment of Integrated Public Health Teams. These teams broaden the responsibilities of polio personnel to encompass a more extensive array of public health tasks such as polio, immunization, health emergencies, disease surveillance, and health systems strengthening.

The objective of transition is to enhance the capacity of health systems and finally delegate responsibilities to governments, once they attain the ability to sustain these responsibilities. In order to advance the capacity of the health system, the Regional Committee of the Eastern Mediterranean has established polio eradication and polio transition as a permanent topic on its agenda.

Surveillance

How Polio Surveillance: Polio surveillance refers to the systematic detection and monitoring of poliovirus in its sole known reservoir, which is humans. This occurs through two methods: monitoring for acute flaccid paralysis (AFP), the main indication of poliomyelitis infection, and monitoring sewage outflow to detect particles of virus that have been excreted in the feces of infected individuals. AFP surveillance is widely recognized as the benchmark for polio surveillance, yet, environmental surveillance is assuming a progressively integral role in the Region. Both techniques require adherence to a specific set of definitive surveillance indications.

Acute Flaccid Paralysis Surveillance: The implementation of the polio programme depends on an extensive network of healthcare professionals, traditional healers, pharmacists, and community leaders throughout the Region to actively search for and promptly report any instances of AFP within their respective communities. Acute flaccid paralysis (AFP) is the primary indication or manifestation of poliomyelitis, the syndrome induced by poliovirus. Predominantly observed in youngsters under the age of 15. As such, the objective of AFP surveillance is to identify, document, and examine all instances of AFP in order to eliminate poliomyelitis as the underlying reason of the paralysis.

Upon receiving a report of AFP, a polio surveillance officer visits the individual's residence or the closest health clinic to get fecal samples. Upon transportation to a WHO-accredited polio laboratory, these samples undergo testing and analysis to determine the presence of poliovirus. Transportation to the laboratory can be arduous, and a primary obstacle for polio surveillance officers is to sustain the samples at a consistent low temperature while they are transported in automobiles, on foot, on donkeys, motorbikes, boats, or airlines. Known as the reverse cold

chain, ensuring that the sample reaches the laboratory in a condition suitable for testing is a crucial performance measure of AFP surveillance.

Environmental Surveillance: Environmental surveillance is the monitoring of sewage runoff to detect the presence of poliovirus. Given that most cases of poliomyelitis are without symptoms, but all individuals who are infected excrete the virus in their feces, the practice of environmental surveillance offers the advantage of enabling us to identify the existence of polio in a certain region far in advance of any manifestation of paralysis. Regular environmental monitoring in areas no longer affected by polio enables us to identify any new occurrence or global dissemination of polioviruses, which poses a substantial risk until polio is completely eliminated. Furthermore, environmental monitoring enables the plan to evaluate the efficacy of the outbreak response by identifying the specific vaccine-virus employed in Immunization operations. An examination of genetic data of polioviruses identified in sewage runoff can reveal the interrelationships between viruses, enabling eradicators to chart their transmission routes and assess the extent of the vaccination effort, if necessary.

For the year of 2020 to 2021, the polio programme extended its environmental monitoring network in the Region, including in Afghanistan, Egypt, Somalia, and Sudan. Furthermore, efforts were initiated in Djibouti, Iraq, Saudi Arabia, and Yemen to develop laboratory capabilities for environmental monitoring.

The Impact of COVID-19 Pandemic on Poliovirus Surveillance: While the COVID-19 pandemic affected surveillance systems throughout the Region, regional surveillance has remained operational throughout the epidemic, adhering to specific rules established by the GPEI to guarantee working safety. In addition, the polio surveillance network, deployed in both field and laboratory settings, has facilitated the pandemic response by establishing surveillance for the reporting and identification of COVID-19 cases, contact tracing, laboratory testing, and data management.

Although faced with the increased effort and the challenges caused by the COVID-19 pandemic, the majority of nations in the Region have successfully achieved and are still achieving worldwide criteria for surveillance indicators.

- The primary objective of GPEI is to halt the continued spread of the wild poliovirus.
- The second primary objective is to develop immunity among the general population by adhering to active polio immunization programs and ensuring timely receiving of vaccine doses by all children.
- The third and last objective is to obtain certification indicating that every state worldwide is entirely devoid of all three strains of the poliovirus, as defined by the World Health Organization, South-East Asia Regional Office, 2019.
- Once we have successfully eradicated the poliovirus worldwide, it is imperative that we shift our attention and resources from poliomyelitis to other avoidable diseases. Thorough preparation for this transition, previously referred to as "the legacy," has always been a crucial element of the overall strategy for achieving the desired outcome. The primary goal is to effectively and securely transfer the knowledge, skills, and understanding related to polio to other global public health priorities once poliomyelitis has been eradicated worldwide (Cochi, 2014).

The vaccination of every citizen of a country is crucial, even after the complete eradication of virus transmission, to prevent inadvertent reintroduction through laboratory leaks. Despite attaining polio-free status, it is imperative that we continue immunization against polio and ensure ongoing protection of our population against potential transmission of the virus. This constitutes the sole method to avert the reintroduction of the infection. Zambon and Martin (2018) to achieve global eradication of poliomyelitis, the use of oral polio vaccine (OPV) is ceased and substituted with extended-release polio vaccine (E-IPV) in developing countries.

This is done to prevent the reoccurrence of poliomyelitis epidemics caused by mutations in the Sabin strains found in OPV recipients (Zambon & Martin, 2018). However, with the inadequate sanitary conditions in Pakistan and Afghanistan, it is not possible to stop OPV immunization. This is because OPV is very efficient in preventing transmission from fecal to oral channel, but IPV is only effective in preventing transmission from oral-to-oral route (Hussain, 2016).

Trials conducted in several countries have clearly shown that using monovalent OPV instead of trivalent OPV for routine vaccination can decrease the likelihood of vaccine-derived paralytic poliomyelitis re-emergence. This is because monovalent OPV does not have the potential to interact with different virus serotypes. Additionally, using E-IPV as a supplementary immunization source increases the seroconversion rates of the vaccines fivefold and enhances their immunogenicity (Ehrenfeld et al., 2009).

Pakistan-Afghanistan Hub

It is imperative to establish a collaborative alliance between Afghanistan and Pakistan with the shared objective of eradicating the wild poliovirus propagating in their northern regions. Coordination of activities is necessary to effectively immunise the children in these regions (States, 2016; World Health Organization, Regional Office for South-East Asia, 2019). The breakout of the corona virus in 2019 precipitated a significant setback to the polio awareness initiatives that had been in progress for several years. Following the shift of global focus from polio to corona, there was a subsequent rise in the number of polio cases in 2019 and 2020. Given our current proximity to our objective, it is imperative that we implement comprehensive polio awareness campaigns. These campaigns aim to rectify the misunderstanding among the local population regarding the safety of the vaccine. The objective is to assure them that immunising their children will safeguard their future and will not result in sterility, a common misconception among the illiterate population of Pakistan (World Health Organization, Regional Office for South-East Asia, 2019). Amidst the epidemic, it is not feasible to coordinate extensive polio campaigns or National polio-eradication days to avoid the concentration of people in one location. Therefore, we must employ innovative strategies instead. The health-care professionals can contribute by offering drive-through vaccination services, while community pharmacists, at a lesser scale, can motivate community members to vaccinate their children (Cochi, 2014; Zambon & Martin, 2018).

Newly established in Lahore, Pakistan is the "AGCT genomics" genomic-sequencing laboratory, which specializes in gene-mapping of the wild poliovirus to identify its origin and transmission. In addition, they conduct laboratory tests on various samples of sewage water to identify the regions of Pakistan that are at risk of polio transmission. The importation of both OPV and IPV vaccinations is undertaken, together with the maintenance of the cold chain. Their services have proven to be highly effective in curbing the spread of the virus. It is anticipated that, with their unwavering dedication and the collaboration of other polio workers, this virus would be completely eliminated from Pakistan by the end of 2022 (The Current tours Pakistan's Polio Lab, 2019). According to NEAP, Pakistan should prioritise the provision of security for vaccination teams. They should be equipped with the necessary equipment and vaccinations, as well as undergo comprehensive training of the personnel (Hussain, 2016). The extended Program on Immunization (EPI) is a crucial platform for the realization of polio elimination. This EPI initiative would facilitate the acquisition of the significant level of government involvement and net investment that Pakistan so far lacks.

Conclusion

The incidence of polio cases in Pakistan experienced a substantial decrease in 2018, bringing us very close to completely eliminating the virus from our country. However, all vaccination efforts were abruptly halted in late 2019 due to the unforeseen emergence of the coronavirus.

Consequently, there was a drastic increase in polio cases once more, necessitating the implementation of new measures during this Covid-19 period. To effectively reduce the risk and consequences of polio infection during this period, it is crucial to uphold robust population immunity levels. This can be achieved by ensuring high vaccination coverage through the implementation of drive-through vaccine services, actively involving community pharmacists and other healthcare professionals in local polio-immunization programs, conducting public awareness campaigns, and implementing rigorous disease surveillance for prompt virus detection and response to the situation. Continued immunization efforts are projected to achieve global eradication of the poliovirus by the end of 2025. Notwithstanding the elimination of the virus, it is imperative for every individual in the nation to have vaccination against the virus in the event of unintentional reintroduction through laboratory or other sources of contamination. After achieving polio-free status, it is imperative to continue the immunization efforts in order to safeguard our population from future transmission of the virus. This is the sole method of preventing the potential reintroduction of the virus. Nevertheless, it is crucial to rigorously control the movement of people residing in countries where the disease is prevalent. Furthermore, to enhance the quality and quantity of people's lives, the government should refocus its efforts on allocating more capital and Gross National Product (GNP) towards the healthcare sector.

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