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Perspective

The re-emergence of wild poliovirus type 1 in Africa and the role of environmental surveillance in interrupting poliovirus transmission

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A B S T R A C T

Although there has been a global reduction in wild poliovirus (WPV) type 1 cases, Africa has experienced a re-emergence of the disease. This article discusses the re-emergence of WPV in Africa, the transmission and pathogenesis of WPV, and the role of environmental surveillance and other strategies used to interrupt all WPV transmission in the region permanently.

1. Introduction

Globally there has been a reduction in the number of wild poliovirus (WPV) cases, with only six reported in 2021. However, the data could be misleading, because these cases were in war-ravaged Pakistan and Afghanistan, where reporting might be poor (WHO Africa, 2022a). Moreover, about 1 in 1000 WPV infections result in acute flaccid paralysis (AFP), meaning that most asymptomatic cases are not detected (Hamisu et al., 2022). Africa was declared free of indigenous WPV in August 2020, after Nigeria, which was formerly considered endemic for WPV type 1, achieved WPV-free status following 3 years of no reported cases (WHO, 2021; Ekwebelem et al., 2021). Poliovirus belongs to the *Picornaviridae* family and there are three types of WPV: type 2 and type 3 were eradicated in 2015 and 2019, respectively (CDC, 2020), while type 1 remains endemic in two countries, Pakistan and Afghanistan (WHO Africa, 2022a), due to people not having received all of the required polio vaccination doses to induce adequate immunity. This article discusses the re-emergence of WPV in Africa, the transmission and pathogenesis of WPV, and the role of environmental surveillance (ES).

2. Re-emergence of wild poliovirus type 1 in Africa

Although Africa was certified polio-free in 2020 by the African Regional Certification Commission after 3 years without a case (WHO, 2021), two cases of WPV type 1 have been reported in Africa this year. One of these cases occurred in Malawi in February 2022, the first WPV case in 30 years, and the other in Mozambique, where an outbreak was declared following a case in Tete Province in May 2022. Both cases were linked to the WPV type 1 strain from Pakistan. WPV type 1 is highly infectious and predominantly affects children younger than 5 years of age. Although the number of cases is low, one case is too many and constitutes an outbreak because the disease is incurable and can result in lifelong disability (WHO Africa, 2022b). A rare circulating vaccine-derived poliovirus (cVDPV) is also affecting African countries with low immunization coverage, especially remote communities and those experiencing migration and conflict (Ming et al., 2020). WPV transmission in Africa is likely to be enabled by the continent's weak and fragile health systems, emanating from poor health governance, inadequate health infrastructure, a shortage of healthcare workers, insufficient essential medicines, and inadequate health funding (Okoroafor et al., 2022). In addition, the importation of polio infections through international travel could be substantial (Wilder-Smith et al., 2015). Conflict and migration could also contribute to the spread of the disease, as displaced people have the potential to carry the virus from one place to another. In addition, refugees are likely to be malnourished and under extreme stress, leading to low immunity against infectious diseases (Akil & Ahmad, 2016). Furthermore, refugees are usually accommodated in crowded camps with a poor water supply and inadequate sanitation, making it easy for the disease to spread (Akil & Ahmad, 2016).

Conflict-affected areas in some African countries, such as Nigeria, the Democratic Republic of the Congo, South Sudan, Ethiopia, and Somalia, have not always achieved the desired immunization coverage. This is attributed to tense security conditions, damaged healthcare infrastructure, and depleted human resources, making it challenging to conduct immunization campaigns and provide outreach services (Grundy & Biggs, 2019). In places with poor sanitation and many unvaccinated children, the attenuated virus in the oral polio vaccine can genetically mutate. The mutating virus may recombine with other vaccine serotypes

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and enteroviruses, resulting in variants reacquiring the ability of the parent wild strains to cause paralytic disease. cVDPV type 2 outbreaks continue to occur due to low immunity to this cVDPV type. This low immunity results from insufficient routine immunization coverage caused by weak health infrastructure in affected countries, global vaccine supply constraints, regional migration patterns leading to missed children in vaccination campaigns, and low-quality outbreak response campaigns (Ming et al., 2020). Anecdotally, the recent emergence of outbreaks, including polio in Malawi and Mozambique and measles in the eastern highlands of Zimbabwe, have been attributed to the low routine vaccination coverage as a result of the disturbance of programs due to the COVID-19 pandemic, which has had devastating effects on health services, particularly immunization (UNICEF Zimbabwe, 2020). Following confirmation of the WPV cases in Malawi and Mozambique, a mass polio vaccination drive was launched with the aim of vaccinating more than 23 million children in five Southern African countries, namely Malawi, Mozambique, Zambia, Zimbabwe, and Tanzania (Santos, 2022).

3. Transmission and pathogenesis of poliovirus

Poliovirus can spread through poor hand hygiene and contaminated food and water. The primary system for detecting poliovirus is case-based syndromic surveillance for AFP, with stool specimen confirmation (Rachlin et al., 2022). AFP surveillance comprises field surveillance and laboratory testing. In field surveillance, all cases of AFP should be notified to the health authorities, and two stool specimens should be collected from each case within 14 days of the onset of the paralysis. The stool samples should be collected 24–48 hours apart and transported on ice to reach the laboratory within 72 hours of collection. Cell culture is used in the laboratory to isolate the virus (Ntsama et al., 2021).

The virus is transmitted mainly through fecal matter or less frequently through contaminated water or food. It then multiplies in the intestines (Rachlin et al., 2022). The poliovirus has an incubation period of between 2 and 35 days. The virus has a particular affinity for the cellular receptor CD135, which helps in its attachment and entry into cells, central nervous system. The cytopathic nature of the virus results in extensive damage to the anterior horn cells of the spinal cord, causing limb paralysis. The poliovirus may also spread to the posterior horn cells, the motor neurons of the thalamus, and the hypothalamus. Infected cells are phagocytosed by macrophages causing the degeneration of axons. This leads to widespread muscular atrophy, which causes flaccid paralysis. In extreme cases, respiratory paralysis may occur, leading to death. The poliovirus can cause paralysis within a few hours, especially in children under 5 years of age (Topley & Wilson, 2005). Vaccination remains the only means of preventing polio, and this can be achieved through the oral poliovirus vaccine (OPV) and inactivated poliovirus vaccine (IPV) (Global Polio Eradication Initiative, 2015).

Quality AFP surveillance, laboratory, immunization, and geospatial data are crucial for monitoring the spread of WPV in communities. However, in Africa, the availability of quality data is hampered by poor collection and documentation and the inability to integrate these data sources for decision-making (Ntsama et al., 2021). AFP surveillance can be affected by pandemics such as COVID-19 and conflicts, resulting in the samples not being collected, or failing to reach the laboratory in time (Manyanga et al., 2021). The accuracy of stool specimen analysis depends on whether an accurate paralysis date was elicited, which may be challenging in cases where people delay seeking health services. Furthermore, some acute AFP cases may go undetected, especially in hard-to-access populations (Wilkinson et al., 2022). With such challenges, Africa may benefit from ES in its efforts to interrupt WPV transmission.

4. Role of environmental surveillance in interrupting poliovirus transmission

Poliovirus is shed in the stool for about 6 weeks during asymptomatic infection and may be detected in sewage or wastewater. Depending on the immediate conditions of the sewage or wastewater, excreted poliovirus particles remain infectious in the environment for different periods. Stool samples from AFP patients have been used to monitor the wild and mutated polioviruses (Asghar et al., 2014). ES is an additional method used to monitor the transmission of poliovirus and is more sensitive than AFP surveillance. ES permits a focused investigation of polio cases and forms a basis for further studies of the risk of poliovirus transmission in the community. However, the sensitivity of ES to detect polioviruses circulating in a specific population will depend on the nature of the sewage network, the appropriateness of the sampling site, and the quality of sample handling and laboratory processing. High sensitivity is crucial for the timely detection of outbreaks. ES involves testing sewage or wastewater samples that may contain polioviruses in human feces. ES relies on sewage collection using different methods such as bag-mediated filtration, composite sampling, virus concentration, and virus detection, usually through cell culture growth (Hamisu et al., 2022). ES can assist in identifying residual WPV transmission in endemic areas, primarily where WPV circulates among infected but asymptomatic individuals (O'Reilly et al., 2018).

ES is also valuable in providing an early indication of new poliovirus importations into polio-free areas, as well as vaccine-derived poliovirus transmission, and for confirming the presence of vaccine-related viruses following vaccination campaigns involving OPV administration. ES helps link poliovirus isolates from unknown individuals to populations served by a standard wastewater collection system (Ndiaye et al., 2014). Despite the importance of ES in controlling and monitoring polioviruses, it only began in 2011 in Africa. Nigeria started ES in July 2011, followed by Kenya in May 2013. Other African countries that began ES in Africa in 2014 include Angola, Madagascar, Cameroon, Chad, Senegal, Niger, Burkina Faso, and Guinea. There are ongoing efforts to strengthen ES in Africa by initiating new sites, expanding old ones, and reviewing existing sites (Gumede et al., 2018). As of April 2022, all of the countries in the World Health Organization Africa Region except two have implemented ES . The number of samples from African countries with cVDPV detected by ES between January 2020 and April 2022 was about 14 500 (Rachlin et al., 2022).

With outbreaks of WPV type 1 in Southern African countries such as Malawi and Mozambique, there is a need to strengthen polio surveillance systems in individual countries and the region. To detect potential future outbreaks in Africa, AFP surveillance and ES should be expanded. Following the case of WPV reported in Malawi in February 2022, the country managed to set up an ES system for poliovirus in 11 cities, including Lilongwe where the case was detected, by mid-April 2022 (Santos, 2022). While AFP surveillance is used to detect the physical symptoms of polio, including paralysis, ES is used to detect polioviruses in samples of wastewater and sewage. Suitable wastewater locations that will serve as ES sites should be identified, and responders at both the local and national level should be trained on collecting and packaging samples for transportation and analysis (Hamisu et al., 2022). The current Global Polio Eradication Initiative (GPEI) guidelines recommend establishing ES sites where there is a convergent sewage network and a catchment population of between 100 and 300 000 people . However, these guidelines may be challenging in African countries where some areas have informal drainage and poorly documented sewerage arrangements. Furthermore, the data on the size of the population in some catchment areas are either not readily available or unreliable (Global Polio Eradication Initiative, 2015). Since maintaining ES may be expensive, neighboring countries may need joint facilities. To increase ES sensitivity, the frequency of sampling will need to be increased. For ES to be more beneficial in polio eradication strategies, there should be an improvement in the timeliness and efficiency of detecting polioviruses in sewage samples. Laboratory and field-training curricula should be developed to ease and speed ES implementation in new areas. The effectiveness of ES should also be monitored and evaluated frequently (Wilkinson et al., 2022).

The COVID-19 pandemic has reduced the sensitivity of AFP surveillance and ES. Therefore, strengthening AFP surveillance and ES is important in tracking progress in eradicating polio and documenting the absence of transmission. In addition, using both AFP and ES would improve the sensitivity of detecting WPV (Bigouette et al., 2021). Furthermore, using ES to monitor WPV circulation would also be beneficial, since it identifies isolates before they undergo a lot of genetic change and gain neurovirulence (Wilkinson et al., 2022).

5. Conclusions

Although there has been a reduction in the number of WPV cases globally, Africa has experienced a re-emergence of the disease. Malawi and Mozambique reported cases of WPV in early 2022. Conflict, migration, and low immunization coverage have been associated with cVDPV in the continent. Poliovirus invades the nervous system and may result in paralysis, other disabilities, or even death. Vaccination remains the only way of preventing polio. As poliovirus is shed in the stool during asymptomatic infection, ES can be used to investigate the risk of poliovirus transmission in communities. Although ES is more sensitive than AFP surveillance, its sensitivity depends on several factors.

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Ethical approval

Not applicable.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Phanuel Tawanda Gwinji: Writing – original draft. **Godfrey Musuka:** Writing – original draft. **Grant Murewanhema:** Writing – review & editing. **Perseverance Moyo:** Writing – review & editing. **Enos Moyo:** Writing – review & editing. **Tafadzwa Dzinamarira:** Writing – review & editing, Supervision.

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