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Importation and outbreak of wild polioviruses from 2000 to 2014 and interruption of transmission in Cameroon

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ABSTRACT

Background: Efficient implementation of the global eradication strategies consisting of Acute Flaccid Paralysis (AFP) surveillance and mass immunization campaigns led to interruption of indigenous wild poliovirus transmission in Cameroon in 1999.
Objectives: This study describes type 1 and type 3 wild poliovirus (WPV) importation, incidence, geographic distribution and control since the original interruption of transmission in Cameroon.
Study design: Stool samples from AFP patients under the age of 15 years in Cameroon were collected nationwide and subjected to virus isolation on RD and L20B cell cultures. Resulting virus isolates were typed by intratypic differentiation (ITD) and analysis of the VP1 coding sequence of the viral genome. Surveillance data originating from Cameroon between 2000 and 2014 were considered for retrospective descriptive analyses.
Results: From 2003 to 2009, multiple WPV importation events from neighboring countries affected mainly in the northern regions of Cameroon but did not led to sustained local transmission. Throughout this period, 16 WPV1 and 5 WPV3 were detected and identified as members of multiple clusters within type-specific West Africa B genotypes (WEAF-B). In 2013–2014, a polio outbreak associated to a highly evolved ("orphan") WPV1 affected four southern regions of Cameroon.
Conclusions: The appearance of highly evolved lineage of type 1 WPV suggests potential surveillance gap and underscore the need to maintain comprehensive polio immunization activities and sensitive surveillance systems in place as long as any country in the world remains endemic for WPV.

1. Background

In 1988, the World Health Organization (WHO) launched the Global Polio Eradication Initiative (GPEI) with the initial objective to interrupt wild poliovirus (WPV) transmission worldwide by the year 2000. The main strategies for the eradication program are the use of extensive immunization campaigns with live-attenuated oral polio vaccine (OPV) and the surveillance of acute flaccid paralysis (AFP) cases. Considerable progress has been registered toward the interruption of WPV transmission worldwide. Four of the six WHO regions have been certified free of indigenous wild poliovirus transmission with only the Eastern Mediterranean and Africa remaining. The American Region has been certified free of indigenous WPV in 1991, the Western Pacific Region in 1997, the European Region in 2002, and the South East Asia Region in 2014.

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The remaining two endemic regions—Eastern Mediterranean and Africa—are also progressing toward polio eradication. WPV type 3 (WPV3) have apparently been eliminated globally and was last isolated in Nigeria in 2012. On the 20th September 2015, the Global Commission for the Certification of Poliomyelitis Eradication (GCC) certified the WPV type 2 (WPV2) eradication worldwide [1,2].

Besides the emergence of pathogenic circulating vaccine-derived polioviruses (cVDPV) [3,4], WPV importation from endemic reservoirs represents one of the major remaining obstacles for the GPEI. With the disappearance of poliomyelitis in most countries, some populations no longer perceive the need for polio immunization. This leads to a decline in vaccine coverage and vulnerability to wild polio importations or cVDPV emergence in previously polio-free countries. During 2003–2011, multiple imported polio outbreaks occurred in 29 previously polio-free countries worldwide [5,6]. With leadership from WHO, great efforts of national programs and support from partners, these outbreaks were promptly interrupted through resumption of mass immunization activities. By 2014, the annual number of WPV cases had decreased by >99% and only three countries remain that have never interrupted WPV transmission: Afghanistan, Nigeria, and Pakistan [7,8]. In 2014, 359 WPV1 cases were reported globally, including 340 from endemic countries (28 from Afghanistan, 6 from Nigeria and 306 from Pakistan), and 19 from non-endemic countries (5 from Cameroon, 5 from Equatorial Guinea, 1 from Ethiopia, 2 from Iraq, 5 from Somalia and 1 from Syrian Arab Republic) [7].

In Cameroon, the introduction of the GPEI program in 1996 resulted in improved routine polio immunization, supplemental immunization activities (SIAs) targeting primarily children <5 years at national or regional levels in response to outbreaks, and active AFP surveillance involving the WHO inter-country laboratory for poliomyelitis at the Centre Pasteur du Cameroon (CPC). In Cameroon, the childhood vaccination schedule for poliomyelitis included four doses of OPV at birth, 6, 10 and 14 weeks of age. Since July 2015, an Injectable Polio Vaccine is administered to 14 weeks old infants at the same time with the 4th OPV dose. The implementation of the GPEI activities led to the interruption of WPV transmission in Cameroon where the last indigenous WPV was identified in 1999 (Cameroon National Certification Committee, Report, 2010). However, importation of WPV type 1 and 3 from endemic reservoir in neighboring countries has been repeatedly reported in Cameroon, as in many sub-Saharan countries in Africa.

2. Objectives

This report aimed to describe the geographic and temporal circulation of WPV and the impact of eradication strategies during AFP surveillance in Cameroon since 1999, the time since indigenous circulation of WPV was originally interrupted.

3. Study design

3.1. AFP surveillance and study population

The study population consisted of AFP patients originating from Cameroon from 2000 to 2014. AFP case was defined as any child <15 years who develops acute onset of focal weakness or paralysis characterized as flaccid (including Guillain Barre Syndrome), without any other obvious cause. When a patient meeting the AFP case definition is presented at a health facility nationwide, the clinician carry out investigations to rule out if poliovirus is potentially involved in the paralysis. Then two stool specimens are collected from each case, 24–48 h apart, within 14 days of onset of symptoms. Case investigation form is filled with clinical, demographic and epidemiologic informations and sent to the CPC via the Expanded Program of Immunization (EPI) in Yaounde. The AFP surveillance database is located at the CPC and shared with the EPI, the ministry of public health and the WHO on a weekly basis.

3.2. Virus isolation and intratypic differentiation

Clarified stool suspensions were prepared and inoculated onto Human rhabdomyosarcoma (RD) and murine L20B (a derivative of murine L cells expressing the PV human receptor) cell cultures according to WHO-specified protocols [12]. Resulting isolates were typed by intratypic differentiation [11,12].

3.3. Sequencing and phylogenetic analyses

WPV isolates were sent to the Center for Disease Control and Prevention (Atlanta, USA) for sequencing according to WHO guidelines [13,14], and identification of poliovirus isolates and inference of their geographical origin through genomic sequence analysis [13] was achieved at the National Institute for Communicable Diseases (Johannesburg, South Africa) or the Centers for Disease Control and Prevention (Atlanta, Georgia, USA). Full-length VP1 sequences were compared to that of previously obtained isolates originating all over the world. A Phylogenetic tree was reconstructed by the neighbor-joining (NJ) method using MEGA version 5 bioinformatics software [15] with the Kimura two parameters algorithm for genetic distance determination. Cluster nomenclature routinely used by the WHO Reference center for molecular epidemiology of polioviruses at the Centers for Disease Control and Prevention (Atlanta, Georgia, USA) was adopted in this report.

4. Results

4.1. Immunization and epidemiology of poliomyelitis in Cameroon

Based on the data of routine immunization activities, the national polio vaccine coverage rate (OPV3; three doses) was estimated to be approximately 57% in 2000; a year after the nationwide interruption of indigenous WPV transmission. This rate subsequently rose to 79% in 2005, 83% in 2010 and 88% in 2013 [16] (Fig. 1) thanks to supplemental immunization activities (SIAs) targeting children <5 years at national or regional levels in order to address low quality routine immunization. However, SIAs focused mainly on the northern part of Cameroon, since this area is in contact with the Northern states of Nigerian and South Chad, which were endemic reservoirs. In contrast, the Southern regions of Cameroon have not held SIAs since 2009, thus rendering them susceptible to polio transmission as revealed by the 2013–2014 outbreaks.

4.2. Isolation of polioviruses

Between 2000 and 2014, the CPC processed approximately 5543 stool specimens collected from 2812 AFP cases within the framework of the active AFP surveillance system in Cameroon. Overall, 25 WP1 and 5 WPV3 were isolated since the original interruption of transmission in 1999 (Table 1).

From 2000 to 2002, no WPV was isolated from the 418 AFP cases enrolled by the surveillance system. However, after 3 years without a WPV, the country faced multiple events of WPV importation from neighboring endemic reservoirs. From 2003 to 2009, 21 WPV (16 WPV1 and 5 WPV3) were isolated from AFP patients with subsequent sustained person-to-person transmission in the country during 2004 for WPV1 (September to November) and 2009 for WP3 (from July to October). The Extreme North region alone registered 11 of the 21 cases, thus accounting for 52.4% of laboratory confirmed WPVs for this period (Fig. 2). Of the 142 AFP cases from 2003,