

Research Article

Evaluation of the Epidemiological Surveillance of Acute Flaccid Paralysis in the Bogodogo Health District from 2016 to 2018 in Burkina Faso

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Abstract

Background: Acute poliomyelitis has been the ground for several epidemic outbreaks over many years and caused high mortality as well as permanent acute flaccid paralysis. However, the disease is under control nowadays thanks to a well elaborated surveillance strategy. The objective of this study is to evaluate the epidemiologic surveillance system for acute flaccid paralysis in the Bogodogo health district from 2016 to 2018. **Methods:** We conducted a cross-sectional evaluation with a quantitative approach over a period of 3 years going from January 1st 2016 to December 31st 2018. Based on the collected data, we estimated the surveillance indicators of the world health organization and the Atlanta Center for Disease Control. The analysis of indicators and surveillance delays did allow the assessment of quality and performance of the surveillance system. **Results:** During our study time in the Bogodogo health district, we recorded 45 suspected cases of acute flaccid paralysis. The key performance indicators, except for two of them (Proportion of samples that were collected in the laboratory within 72h after collection and proportion of active surveillance reports received) were meeting the criteria of the world health organization. The sensitivity and the positive predictive value were respectively of 94% and 100%. However, the laboratory results were incomplete, only representing 18% of cases, and the mean delay for sample transport to the laboratory was of 11 days which was out of normal range according to the world health organization. **Conclusion:** Our results show a satisfying global performance of the surveillance system in the Bogodogo district, but the implementation of our recommendations will help improve the current practices.

Keywords

Surveillance System, Acute Flaccid Paralysis, Evaluation, Bogodogo, Burkina Faso

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1. Introduction

Since 1988, acute flaccid paralysis (AFP) was occurring in 125 countries with 350 000 cases yearly and 5 to 10% of mortality despite the availability of a 30-years old vaccine. This gives a record of about 1000 new cases of paralysis and 50 to 100 deaths daily, affecting children mainly [1]. The disease can be very contagious and cause irreversible AFP epidemic outbreaks and high mortality with socio-economic burdens on the population if its surveillance is flawed. WHO considers any confirmed case of polio paralysis to be an epidemic because rapid, silent transmission occurs long before the first case appears. and each diagnosed case could cause an asymptomatic viral transmission to almost 200 people [1]. The visible manifestation of the infection is AFP, which occurs only in rare cases, i.e. 1/200 for wild virus type 1, 1/1200 for wild virus type 3 and 1/2000 for wild virus type 2 [2].

In 2013, only three countries worldwide had endemic poliovirus reservoirs: Afghanistan, Nigeria and Pakistan [3]. In 2015, episodes of poliovirus international spread occurred across the common borders of Pakistan and Afghanistan [4]. The transmission of wild poliovirus (WPV) continue to be notified in Afghanistan and Pakistan [5-7], and environmental surveillance isolated wild poliovirus type 1 (WPV1) from four samples collected from different sites in Karachi, Pakistan in September 2023 [8]. Indonesia reported four cases of circulating vaccine-derived poliovirus type 2 (cVDPV2) from October 2022 to February 2023. On November 20th and 27th, 2023, the Ministry of Health in Indonesia reported two new confirmed cases of cVDPV2 to the WHO [9].

In 2013, the WHO African region reported an ongoing transmission of wild poliovirus type 1 as well as vaccine-derived polioviruses with a total number of 80 cases of paralysis caused by poliovirus type 1 and 1 cases caused by circulating vaccine derived polioviruses in four countries [3]. More recently, on July 4th 2023, the Ministry of health of the United Republic of Tanzania reported a case of circulating vaccine-derived poliovirus type 2 (cVDPV2) in the country [10]. The WHO African region was certified freed from wild poliovirus on August 25th 2020. In order to eradicate all forms of poliomyelitis, the region fights against epidemic outbreaks from circulating vaccine-derived poliovirus type 2 (cVDPV2). Burkina Faso has complied to the different interventions that aimed at eliminating the virus. However, despite the fact that the country is freed from wild poliovirus since 2015, 73 cases of vaccine-derived polioviruses have been notified from 2019 to December 2022 [11]. That is why Burkina Faso, alongside other countries, uses the novel oral poliomyelitis vaccine type 2 (nOPV2) that was approved by the WHO as the best choice of vaccine to counter the outbreaks of cVDPV2 in November 2020. Thanks to the United Nations International Children's Emergency Fund (UNICEF) and WHO, the country used the vaccine for the first time in a large national vaccine campaign against poliomyelitis during four days from November 22nd

to 25th, 2022. The target population was of 4.6 million children less than five years old.

The challenges regarding the eradication of the disease are persistent despite the certification in 2015 and concern the regular assessment of the surveillance system and the constant health monitoring. The AFP continue to be a public health concern in Burkina Faso. It is essential to regularly evaluate the surveillance system in order to support the worldwide initiative of eradicating poliomyelitis. The Bogodogo district was strongly affected with 6 reported cases out of the 48 reported at the beginning of 2019. The current study aims at evaluating the surveillance system in the Bogodogo district in order to improve its performance in the eradication process. The results of this evaluation will offer a database for future comparisons of surveillance performances three years after the introduction of nOPV2.

2. Material et Methods

2.1. Study Environment

The study was conducted in the health district of Bogodogo, located in the south east part of the Kadiogo province in Burkina Faso. In 2021 this district spread over 1167.77 km², with a population on 1 004153 inhabitants both from rural and urban areas.

This high density is causing anarchy in population settlement especially in «zone of spontaneous habitation » or « underdeveloped zones ». This leads to promiscuity that makes it difficult to carry out prevention activities (epidemiologic surveillance and vaccination).

The urban zone of the district is offering development of informal activities such as market places, bus stations, with poor hygiene which can cause the spread of diseases such as poliomyelitis.

The health system of the Bogodogo district, similar to the national health system, is divided into three level (central, intermediary and regional). The epidemiologic surveillance of AFP is integrated in the different levels of the system, combining both passive and active approaches. The district is actively involved in disease prevention which constitutes a major public health activity.

2.2. Type of Study

We conducted a cross-sectional study with retrospective analysis of data from January 2016 to December 2018 in the 136 health centers in the Bogodogo health district.

2.3. Population of Study and Inclusion Criteria

Our study population was made of health centers and children below age 15 who lived inside the district's borders. We

included in our study, all health centers belonging to the Bogodogo district and all children below age 15 whom were suspected to have AFP during the study period.

2.4. Sampling

The selection was made by recording the totality of participants included in the study. We included all children below age 15 whom were suspected of have AFP and were recorded during the study period in the different health centers of the district (136).

2.5. Techniques, Tools and Procedures for Data Collection

The data collection was done using two main methods. First of all, a documentary review was performed using registries for outpatient visits, hospitalized patient records, and AFP notification forms in the different health structures within the district. At the same time, secondary data were extracted. For this reason, a questionnaire and a grid for secondary data extraction were set up and validated after a pre-test. Thereafter we proceeded to the data collection using the questionnaire while data extraction through the grid was performed by the district's Center of Health Information and Epidemiologic Surveillance. The data collection occurred over a one-month period and was authorized by the country healthcare officials. The process guaranteed confidentiality and anonymous data recording.

2.6. Study Variables

The collected variables were related to:

- 1) Patient characteristics: age, recorded in years just as mentioned in the notification form, categorized in age groups 0 to 4 years, 5 to 9 years and 10 to 14 years. The gender was also recorded (Male:1/ Female: 0) as well as the residence zone (urban:1/ Rural:0) and the health center of provenance
- 2) notification: date of notification, type of notification, hospitalization, date of hospitalization
- 3) Clinical features: date of investigation, clinical signs, onset of paralysis, AFP confirmed, vaccine statute, number of doses
- 4) Stool samples: date of 1st sampling, date of 2nd sampling, date of transportation to the Department for Prevention through Vaccination, date of transportation from the Department for Prevention through Vaccination to the lab, date of reception at the national lab
- 5) results of stool samples: sample's aspect, date of expedition of the results from the lab to the district, date of reception at the district, isolation of results
- 6) patient follow up: follow up on day 60th, date of follow up exam

2.7. Operational Definition of Main Terms and Concepts [12]

The definitions of the terms «AFP case», «confirmed poliomyelitis case», «sensitivity», «positive predictive value (PPV)», «completeness of data», «reactivity», «surveillance delay» and «variables regarding the performance results of the system» that are used in this study are the followings.

- 1) AFP cases: Every child below age 15 who presents with an AFP including the Guillain Barre syndrome or anybody having a disease with paralysis regardless of his age if poliomyelitis is suspected.
- 2) Confirmed case of poliomyelitis: Any suspected AFP case in which the wild poliomyelitis virus was isolated in the laboratory.
- 3) The quality of the system. The Centers for Disease Control and Prevention (CDC) defines quality indicators for a surveillance system [13]; we considered the following indicators with WHO standards:
- 4) Sensitivity: represents the capacity of the system to detect the event under surveillance. It corresponds to the proportion of AFP cases formally identified by the surveillance.
- 5) Positive predictive value: represents the probability of the system to properly identify a confirmed case. It represents the proportion of suspected notified cases in the system which were confirmed after investigation according to the WHO operational definition.
- 6) Completeness of data: refer to the exhaustivity of recorded data on the AFP notification and investigation forms [14].
- 7) Reactivity: concerns process delays, from hospitalization to sample transportation to the laboratory, as defined by the WHO. These delays include: hospitalization to notification (WHO standard ≤ 24 h), notification to investigation (WHO standard ≤ 24 h), and time for sample transportation to the laboratory (WHO standard ≤ 72 h).
- 8) Surveillance delay: It represents the time interval between the different steps of the system, measured in days, including time between the onset of paralysis and hospitalization, between hospitalization and notification, between notification and investigation, and between the sample collection and its reception in the laboratory.

Indicators regarding the performance results of the system [12]. The indicators related to the results of the system include its performance which stand for the capacity of the institution to carry out its missions and generate expected results. In the AFP epidemiologic surveillance, the WHO assesses performance through indicators; we accessed nine. The first indicator is the non-polio AFP proportion in children below age 15, expressed in number of cases per 100 000 children below age 15, with a WHO standard above 2. The second indicator is the proportion of AFP with two samples collected in a time lag of 24 hours and within 14 days following the onset of the

paralysis, with a WHO standard set above 80%. The third indicator is the proportion of investigated AFP within 48 hours following notification, with a standard set above 80%. The fourth indicator is the proportion of samples received in the laboratory within 72 hours after being collected, with a standard set above 80%. The fifth indicator is the proportion of expected results from the laboratory within 14 days following sample reception, with a standard set above 80%. The sixth indicator is the proportion of sample received in the laboratory in good condition, with a standard set above 90%. The seventh indicator is the proportion of received active surveillance reports, with a standard set above 90%. The eighth indicator is the proportion of samples tested positive to non-polio enteroviruses, with a standard set above 80%. Finally, the ninth indicator is the proportion of followed up cases on day 60th, with a standard set above 90%. According to the WHO, the first two indicators are the key ones in assessing the performance a surveillance system [3].

2.8. Data Analysis

The collected data were recorded twice on excel sheets. After data sorting and coding of variables the statistical analysis was performed through the Statistical software for data science STATA 14.0 by importing data using the “import” command.

The analysis consisted in describing (tallies and proportions) the sample according to the different variables of the study: the characteristics of the of AFP cases, the performance indicator of the surveillance system, the quality of the surveillance system of AFP based on the quantitative attributes (sensitivity, PPV, data completeness, reactivity) defined by WHO and the Atlanta CDC [12, 13].

- 1) The sensitivity of the surveillance system was calculated through the proportion of the number of notified AFP by the surveillance system over the number of identified AFP recorded in the registries for outpatient visits in reference center for AFP care (Bogodogo University Hospital, Charles de Gaulle Pediatric University Hospital).
- 2) The positive predictive value of the surveillance system was calculated through the proportion of the number of cases meeting the operational definition of the WHO over the total number notified cases by the system.
- 3) The completeness of surveillance data was assessed from the frequency of available data (in the investigation forms) regarding the different key variables for analysis: clinical signs, vaccine statute, date of notification, results of laboratory etc.

- 4) the reactivity of the surveillance system was assessed by comparing the different surveillance delays to the WHO standards.

The Wilcoxon non parametric test was used to compare the means of surveillance delays between the rural zone and the urban zone of the district. The threshold for significance was set at 5%.

2.9. Ethical Considerations

An appropriate authorization was obtained from the chief physician of the Bogodogo health district and the heads of the various health facilities for data collection. The tool was designed to be anonymous, and the result did not identify the personalities of the respondents; rather it was presented as aggregated statistics. The data was kept in a protected and safe location.

3. Results

3.1. Characteristics of Cases

Between 2016 and 2018, a total number of 45 AFP suspected cases were notified in the Bogodogo health district with 18 cases in 2016, 7 cases in 2017, and 19 cases in 2018. The children below age 5 were the most affected ones and represented 73.33% of cases ($p=0.001$), the sex-ratio male/female was of 1.14. All cases of AFP were vaccinated and 97.78% of them had received at least 3 vaccine doses. About 60% of cases were coming from the district's urban zone.

3.2. Performance Indicators

The key performance indicators, namely the indicator n°1 (proportion of non-polio in children below age 15 (cases per 100000 children) and n°2 (Proportion of AFP with two samples collected in 24 hours and within 14 days following the onset of paralysis), met the standards of the WHO during our study period, giving (2.93 and 2.89 cases per 100 000 children) and (100% and 94.74%) respectively. However, the indicators n°4 (Proportion of sample received in the laboratory 72 hours after being collected) and n°7 (Proportion of received active surveillance reports) did not meet the WHO standards, giving (11.11%, 0% and 5.26%) and (63.33%, 62.02% and 61.19% Table 1) respectively.

Table 1. Performance indicators of active surveillance for Acute Flaccid Paralysis from 2016-2018, Bogodogo health district.

Performance indicators	2016	2017	2018	WHO standards
1- Non polio AFP in children below 15 (case per 100 000 children)	2.93	1.26	2.89	>2

Performance indicators	2016	2017	2018	WHO standards
2- Proportion of AFP with two stool samples collected in 24 hours within 14 days following the onset of paralysis.	100	87.5	94.74	>80%
3- Proportion of investigated AFP in the 48 hours after notification	94.44	100	100	>80%
4- Proportion of samples received in the laboratory within 72h from the collection time	11.11	00	5.26	>80%
5- Proportion laboratory results received within 28 days of sample reception	100	100	100	>80%
6- Proportion of samples that were received in the laboratory in good condition	100	100	100	>90%
7- Proportion of received active surveillance reports	63.33	62.02	61.19	>90%
8- Proportion of specimen tested positive to non-polio enteroviruses	27.78	00	15.79	>10%
9- Proportion of cases followed up on day 60 th (%)	----	100	100	>90%

3.3. The Quality of the System

The sensitivity was evaluated at 94% while the positive predictive value was at 100%. The data on completeness revealed that laboratory data were incomplete, with a fre-

quency of 18%. When we considered the reactivity of the surveillance system, we noticed that the delay to sample expedition to the laboratory was the only aspect that did not meet the WHO standard (≤ 72 h). The comparison of surveillance delays did not reveal a significant difference between the district's urban and rural zones (Table 2).

Table 2. Comparative analysis of delays between urban and rural areas, Bogodogo health district.

Delays	Urban Zone		Rural Zone		Wilcoxon (P value)
	Mean	Median	Mean	Median	
	(SD)	(Q ₂₅ - Q ₇₅)	(SD)	(Q ₂₅ - Q ₇₅)	
1-the onset of paralysis and hospitalization	0.88j (+/-0.99)	0.5j [0-2]	4.2j (+/-8.84)	1.5j [0-2]	0.3259
2-hospitalization and notification	3.38j (+/-4.44)	2j [0-5]	1.3j (+/-1.34)	1j [0-2]	0.4637
3- notification and investigation	0.19j (+/-0.68)	0j [0-0]	0.06j (+/-0.24)	0j [0-0]	0.7683
4-sample collection and reception at the laboratory	11.04j (+/-7.37)	10j [6-14]	11.33j (+/-6.22)	11j [7-13]	0.6340

4. Discussion

Our study has significant method flaws. Although the Bogodogo district was chosen due to its geographic accessibility and high number of poliomyelitis, the choice could lead to a selection bias. However, the mixture of rural and urban zone in the district could temperate this bias. Since our study was conducted in only one of the seventy districts of the country, we are limited in our attempt to make our findings representative of the health system in Burkina given the small sample size and the associated weak statistical power. Moreover, we encountered difficulties in accessing archived

data due to poorly archived registries or shortcomings in the process of archiving.

Despite these limitations, the key performance indicators were satisfying during the period of study, as the positive results reported in the rapid evaluation of AFP surveillance conducted in December 2017 in Burkina Faso and as recommended by WHO and the Global Polio Eradication Initiative (GPEI) [15, 16]. The non-polio rate and the proportion of properly collected stools were respectively of 3.33 cases per 100 000 children below age 15 and 85.11% for the country. Our results are similar to findings of studies in other countries [17-20]. During this period, five other indicators (indicator n°3, n°5, n°8, n°6 and n°9) were also satisfying, demonstrating a good sensitivity of the system, a promptitude in the

collection of stool samples, a rapid onset of investigation, a compliance in keeping the notification delays of laboratory results and an exhaustivity of follow up after 60-days. However, the indicators (n°4 and n°7) were declining especially n°4, which revealed a longer delay in the transportation of stool samples to the laboratory, with proportion that did meet the standard delay of 72 hours ranging from 0 to 11.11%. The same findings were reported by Conte in 2014 in Guinea [21] who noticed a decline on indicator n°4 with proportion ranging from 40 to 70%.

The delay in stool sample transportation could be due to communication problems within the district and in the department of prevention through vaccination. Within the department of prevention through vaccination, the expedition of the samples to the WHO laboratory in Abidjan only occur on Mondays and Thursdays and may cause longer delays. The indicator n°7 show non completeness in surveillance reports, mainly due to the weak involvement of private health centers. In 2017, the poor notification with only 1.26 cases per 100 000 children below age 15, and the decline in three indicators of performance (n°4, n°7 and n°8) could be related to the rotations of healthcare personnel at the end of year 2016, which lowered vigilance and performances. The analysis of performance indicators such as the indicator of sensitivity (indicator n°1) corresponding to the rate of non-polio AFP gives a tendency of good sensitivity of the system. The sensitivity of 94% calculated according to the attributes defined by the Atlanta CDC does confirm this tendency. Our results are however lower than those met in Democratic Republic of the Congo and in Nigeria [22, 23]. They are superior to those reported by Bouharrass in 2012 in Morocco [24] a who reported a sensitivity of 40%. The degree of sensitivity in our surveillance system does reflect the capacity of the system to detect AFP.

The calculated positive predictive value of the surveillance system was of 100% in our study. Our results are similar to those reported by Bouharrass in 2012 in Morocco [24] who reported a PPV of 86%. Since we used a passive notification for all recorded cases (100%) in our study, the reported results show a good knowledge on acute flaccid paralysis clinical signs by clinicians especially regarding the definition of cases and the differential diagnosis. The completeness of data was satisfying, except for the lab results reported at only 18%. This low rate could be explained by the delay between the reception of results and the archiving of forms, as well as the lack of verification of filled forms by the head of the surveillance unit. In our study, the surveillance system appeared to be reactive initially, but showed flaws subsequently. The time lag for conveying samples to the laboratory was of 11 days, largely beyond the 3- day time lag as recommended by the WHO. The time lag between the district and the department of prevention through vaccination (media of 6 days) as well as between the department of prevention through vaccination and the laboratory (median of 4 days) confirm the delay, which is in concordance with the decline in performance that was observed with indicator n°4,

both at the district level and the department of prevention through vaccination.

The analysis of the surveillance delays did not reveal a significant difference between rural and urban zones within the district. This finding contradicts the results Bouharrass in Morocco in 2012 [24], which evidenced a significant difference in delays, especially when considering the time lag between the onset of paralysis and hospitalization. Our conclusions do suggest a similar accessibility to healthcare structures both in the rural and urban zone of the district.

5. Conclusions

The current study, conducted in the Bogodogo health district, assesses the epidemiologic surveillance of AFP. It consisted in a cross-sectional evaluative study with a quantitative approach over a period of 3 years. The analysis of the results revealed a performance and a quality of surveillance that were globally satisfying. However, a number of indicators such as the promptitude of stool sample transportation and the exhaustivity of reports require several improvements in order to meet the WHO standards of certification. To the Ministry of Health, it is imperative to review the schedule for transporting specimens to the national laboratory, ensuring compliance with the three-day deadline for sending samples. To the Bogodogo health district level, active surveillance of AFPs must be strengthened and compliance with the deadlines for transporting samples to the DPV must be ensured, ensuring that laboratory results are correctly reported on the investigation form, while verifying the accuracy of the completion of the notification forms. Despite the identified flaws, the study sets the basis for future research especially qualitative approach in order to better explore and comprehend the flaws in the system. The results of this evaluation will serve as baseline data for subsequent comparison with surveillance performance three years after the introduction of nVP2 in the country in November 2022.

Abbreviations

AFP	Acute Flaccid Paralysis
WHO	World Health Organization
WPV	Wild Poliovirus
WPV1	Wild Poliovirus Type 1
cVDPV2	Circulating Vaccine-Derived Poliovirus Type 2
UNICEF	United Nations International Children's Emergency Fund
nOPV2	Novel Oral Poliomyelitis Vaccine Type 2
CDC	Centers for Disease Control and Prevention
STATA	Statistical Software for Data Science
PPV	Positive Predictive Value
GPEI	Global Polio Eradication Initiative

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Author Contributions

Pauline Kiswendsida Yanogo: Conceptualization, Formal Analysis, Methodology, Writing – original draft

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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