GLOBAL BIOSECURITY

M Raphael, DC Adam, AA Chughtai, A Kelly-Hanku, D Hutchinson, Y An Lai & CR MacIntyre. Poliomyelitis epidemic in Papua New Guinea, 2018. *Global Biosecurity, 2022; 4(1).*

RESEARCH ARTICLES

Poliomyelitis Epidemic in Papua New Guinea, 2018

Mark Raphael[1], Dillon Charles Adam[2], Abrar Ahmad Chughtai[3], Angela Kelly-Hanku[2], Danielle Hutchinson[2], Yi An Lai[2], Chandini Raina MacIntyre[2]

[1]Papua New Guinea Institute of Medical Research
[2]Biosecurity Program, Kirby Institute, University of New South Wales, Australia
[3]School of Public Health and Community Medicine, University of New South Wales, Australia

Abstract

Background: Vaccine-derived poliovirus (VDPV) remains a significant barrier to global poliomyelitis eradication. Following 18 years of polio-free status, an epidemic of circulating VDPV type 1 (cVDPV1) occurred in Papua New Guinea (PNG) in 2018. We describe the epidemiology of the 2018 cVDPV1 epidemic in PNG, and identify risk factors which may aid future policy and control efforts.

Methods: Data pertaining to the 2018 PNG epidemic were extracted from EPIWATCH and supplemented with data from other sources, such as the World Health Organization (WHO), and published literature. Descriptive analyses were undertaken, and key risk factors identified.

Results: 26 cases of cVDPV1 were confirmed throughout the duration of the epidemic (April to October 2018) in nine provinces. Of the 26 cases, 19 (73%) were males and 7 (27%) were females, and most of the cases (73%) occurred in children under the age of five. Population immunization coverage of three doses of oral polio vaccine (OPV3) was found to fluctuate between 60- 80% between 2000 and 2018. Nonpolio Acute Flaccid Paralysis (NPAFP) surveillance rates were also found to be suboptimal over this period.

Conclusions: A combination of low routine immunization coverage, lacking supplementary immunization activities, and ineffective surveillance systems, in the context of a struggling health system, culminated in this epidemic. To prevent future poliomyelitis epidemics in PNG, emphasis must be placed on supporting the health system to maintain high vaccination coverage, in conjunction with robust and effective surveillance systems.

Keywords: Vaccination coverage, Acute Flaccid Paralysis, Papua New Guinea, Poliomyelitis, Disease Outbreaks, Poliovirus Vaccine, Risk factors

Introduction

Papua New Guinea (PNG) is the largest and most populous nation in the Pacific, and was declared polio-free by the World Health Organization (WHO) in 2000 [1]. However, a case of Vaccine Derived Polio Virus 1 (VDPV1) was reported in April 2018 in a 6-year-old child in Lae, Morobe Province [2]. This paper describes the epidemiology of poliomyelitis in PNG within the context of the 2018 VDPV1 epidemic to identify underlying predisposing factors.

Poliomyelitis is a highly infectious disease caused by poliovirus, an RNA enterovirus. Transmission occurs through the faecal-oral route, and most cases are asymptomatic or mild [3]. However, in approximately 0.5% of cases, poliovirus can spread to the spinal cord and cause acute flaccid paralysis (AFP) [3].

The widespread adoption of the oral polio vaccine (OPV) by the Global Polio Eradication Initiative (GPEI) has been successful in reducing the incidence of wild poliovirus (WPV) by >99.9% since 1988 [4]. OPV contains live but attenuated poliovirus and carries the risk of vaccine-derived poliovirus (VDPV), which has the potential to cause paralytic disease and threatens global polio eradication [4]. VDPVs emerge in settings where there is poor sanitation, immunity against polio is low, and the live Sabin virus in the OPV is allowed to mutate into a variant form that can cause paralysis [5]. Following OPV administration, some of the live Sabin virus may combine with native gut enteroviruses (e.g., Coxsackie virus) in the small intestine, subsequently undergoing mutation [6,7]. The divergent strain may then cause disease in unvaccinated children who are in contact with the faeces of vaccinated children and are therefore exposed to the virus [8,9]. Bivalent OPV remains in use in many countries, including PNG, due to the low cost and ease of administration [10].

Annual nonpolio AFP (NPAFP) rates are used to assess AFP surveillance performance [11], where stools of AFP cases are sent to the WHO reference laboratory to confirm the absence of polio virus. According to GPEI, countries are considered to have highly sensitive polio surveillance systems if NPAFP rates are ≥2 per 100,000 children <15 years old [11].

Methods

Primary outbreak alerts were extracted for analysis from EPIWATCH, a semi-automated outbreak data collection and analysis observatory that monitors and provides critical analysis of global outbreaks and epidemics of public health significance using only publicly available sources [12]. The EPIWATCH system uses artificial intelligence to scan huge amounts of open-source data globally, in multiple languages with geographic information in real time, to identify early warning signals of potential epidemics [12,13]. This may provide particularly useful data from countries with low diagnostic and surveillance capacities due to a lack of resources [13].

Data from EPIWATCH was extracted using the keywords, "Papua New Guinea + Polio + outbreak + epidemics". Data from 14 relevant posts for poliomyelitis in PNG were collated and set the basis for additional resources required to summarize the epidemic, including journal papers and other public domains including the WHO [2,14-16].

Map data for PNG was sourced from the United Nations Office for the Coordination of Humanitarian Affairs Data Exchange (https://data.humdata.org) [17]. Maps were generated using the ggplot2 package in R version 4.1.1 (R Foundation for Statistical Computing).

Case numbers per province were collected from WHO [15]. Population data from the most recent population census was collected from the PNG National Statistical Office [18]. Data were extracted from WHO for NPAFP reporting in PNG from 2000 to 2018 [15].

Results

Vaccine-derived poliovirus (VDPV) epidemic in PNG

The index case was a 6-year-old boy in Lae, Morobe Province who presented with AFP on 24 April 2018 [2]. Stool samples were sent to the WHO regional polio reference laboratory, which isolated VDPV1 [2]. In response to the index case, active case finding was conducted, and in June 2018, the regional polio reference laboratory reported the isolation of VDPV1 from the stools of two healthy community contacts of the index case. The samples were sent for analysis to the global polio reference laboratory at the United States Centers for Disease Control and Prevention (US CDC) and it was confirmed that the isolates were genetically linked to the index case [16]. The subsequent 310 cases were found through enhanced surveillance of AFP, of which 26 were confirmed to have cVDVP1 isolated in the stool [2].

On 20 June, WHO reported cVDPV1 was isolated from the stool of two household contacts of the index case and confirmed a polio outbreak [16]. Genetic analyses linked the two household contacts to the index case indicating prolonged viral replication and circulation [16].

The PNG government established a National Emergency Operations Centre to coordinate the outbreak response on 27 June 2018 [16]. This included nationwide supplementary immunization activities (SIA), a community-focused risk communication campaign, and enhanced surveillance for AFP [16]. Vitamin A supplementation was integrated into the second and third rounds of the nationwide polio campaign [19].

Case detection and identification

The 2018 cVDPV1 Polio epidemic comprised 26 confirmed cases from nine (41%) of the 22 provinces of PNG. The Eastern Highlands Province recorded the highest number of cases (Figure 1) [15]. Immunization coverage rates were lower in Morobe (where the initial case was identified), and the neighbouring provinces of Madang and Eastern Highlands, when compared to the national rate [20]. This was in part caused by poor health literacy, low socioeconomic status, and poor geographical accessibility [20]. Of the 26 total cases, 19 (73%) were male and seven (27%) were female; 19 (73%) cases were less than 5 years, six (23%) others were from 5 to 14 years while one (4%) was a 17-year-old [2]. Most cases developed onset of AFP symptoms from the month of June 2018, peaking in August 2018 [2]. Figure 2 shows the epidemiological curve of all confirmed cases.

Oral polio vaccine 3 (OPV3) coverage in PNG

OPV3 coverage is used as an indicator to measure country-level performance in providing immunity against poliomyelitis [1]. Data extracted from WHO revealed that the coverage rate in PNG of OPV3 remained consistently below 70% between the years 2000 to 2018, with a downward trend after 2009 [15]. SIA were conducted in PNG in 1997,1999, 2003, 2008, 2010 and 2012 due to persistently low OPV3 coverage, however it was observed that most of the SIA did not meet their target rate of 95% [14].

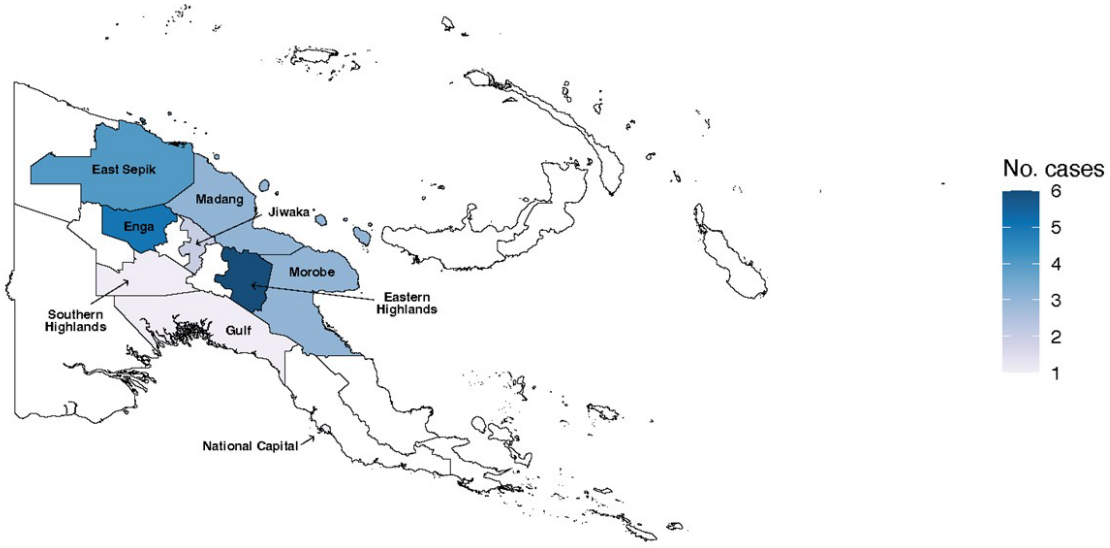
In response to the cVDPV1 epidemic in 2018, the PNG National Department of Health and its partners, including WHO, aimed to immunize 3.2 million children [16,20]. There were five rounds of immunization in total. The first two rounds were conducted sub-nationally, covering children <5 years in affected provinces in July, August and September 2018 [2,15]. The third and fourth rounds were conducted at the national level covering children <15 years in October and November 2018 [2,15]. The fifth round was conducted in selected provinces in December 2018. A total of 7.8 million vaccines were administered, with the WHO reporting 97% vaccination coverage by the end of 2018 [15,16].

AFP surveillance

NPAFP rates used to assess surveillance performance in PNG was consistently below the required annual rate of 2 per 100,000 children <15 years old, from 2000 until the 2018 epidemic [16].

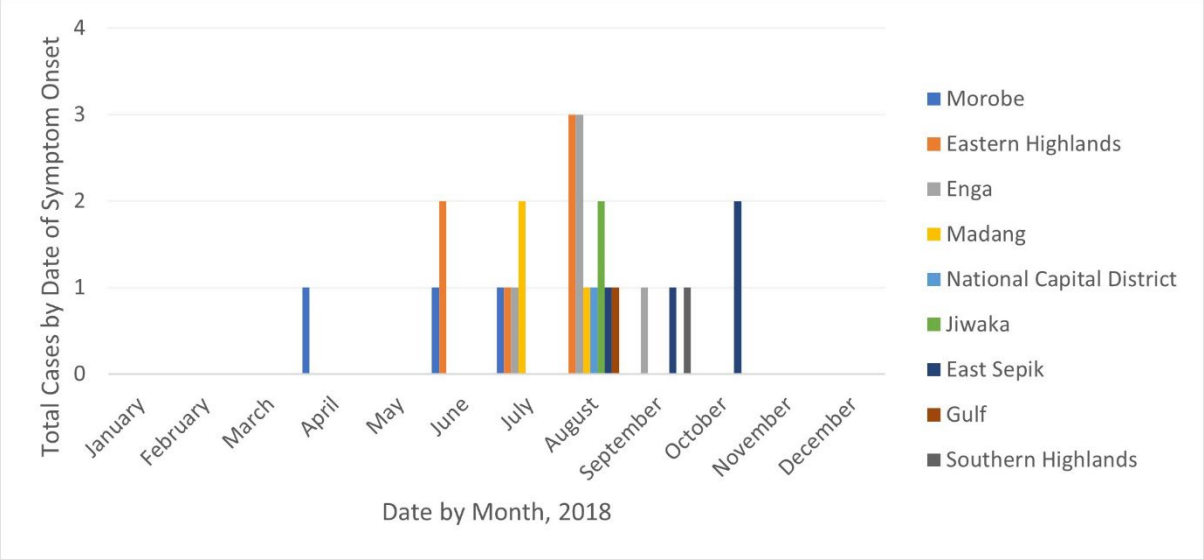
During the 2018 epidemic, the response team strengthened the AFP surveillance system. Health care

Figure 1. Map of PNG provinces with case number and case rates per 100,000 population



Source: United Nations Office for the Coordination of Humanitarian Affairs Data Exchange (https://data.humdata.org).

Figure 2. Epicurve of confirmed cases by date of symptom onset



Source: EPIWATCH/WHO/Bauri et al, 2019.

workers including surveillance officers, field epidemiologists and clinicians were trained to identify, collect, and transport samples, and report suspected cases [16]. The Ministry of Health along with provincial health departments conducted surveillance in health clinics and registered households, while humanitarian agencies such as PNG Red Cross Society targeted high risk and unregistered children [20]. By the end of 2018, the number of AFP cases reported from the surveillance was 310, of which 26 cases had cVDVP1 isolated in the stool [2]. The annual NPAFP rate was more than 7.0 per 100,000 persons aged <15 years in 2018 due to improved surveillance, compared with 0.8 in 2017 [2]. To complement the AFP surveillance, environmental sampling was undertaken in Morobe Province and the National Capital District (NCD). Of 27 samples taken, seven tested positive, mainly in the NCD [16]. No further cases of polio have been reported since 2018 [15].

Discussion

VDPV is an emerging threat to the global polio eradication effort. PNG was declared polio-free in 2000, however the years that followed were characterised by very low routine immunization coverage and poor polio surveillance [1]. Findings from a 2005 survey identified that weaknesses in the health system, low vaccine

knowledge, and barriers around accessibility and transportation were linked with low immunization coverage in PNG [21].

While the use of OPV3 in routine and supplementary immunization programmes confers protection against polio for the PNG population, it also increases the number of viral strains available for replication and genome mutation, thus increasing the risk of a cVDPV outbreak [5,9].

Adequate AFP surveillance is necessary to accurately identify WPV and cVDPV cases in the community [16]. However, in PNG, the non-AFP rate remained under the required annual rate of 2 per 100,000 children <15 years old, from 2000 until the 2018 epidemic [16].

The response by the WHO, UNICEF and PNG authorities to the 2018 epidemic was done at both the national and provincial level, reaching above the targeted 3.2 million children and improving the national coverage rate to 97% [16]. These initiatives also improved the non-AFP surveillance rate to 7 per 100 000 children <15 years old compared to 8 per 100 000 children <15 years old in 2017 [16]. Given that no further cases of polio have been reported since 2018, these interventions have been successful in halting transmission. To ensure the long-term eradication of poliomyelitis in PNG, human and other resources must be directed towards maintaining high vaccination coverage along with ensuring a robust surveillance system is maintained [16]. Tracking unvaccinated people, improving the reach and efficiency of outreach services, and improving staff and community knowledge about vaccination are all areas that have been identified to improve the performance of the national immunization strategy in PNG [22].

Limitations

There are some limitations to the current research. Firstly, inadequate surveillance of AFP can lead to underreporting and impact the accuracy of any inferences made. Secondly, primary outbreak alerts were extracted from the EPIWATCH system. Although data from EPIWATCH provides early signals that trigger further investigation, the number of reports is not equivalent to case numbers. However, the data were supplemented by other sources to provide a comprehensive picture of the 2018 epidemic.

Conclusion

The 2018 cVDPV1 epidemic in PNG resulted in 26 AFP cases across nine provinces. Factors leading to this epidemic included low population vaccination rates, routine use of OPV, and inadequate surveillance, in the context of a poorly resourced health system. The outbreak response improved the national OPV3 coverage rate to 97% and strengthened the AFP surveillance and monitoring system. To ensure sustainability of these gains, resources directed at maintaining high vaccination coverage, improving surveillance systems, and improving the capacity of outreach services will provide the nation with the best protection against not just poliomyelitis, but also future threats from other vaccine-preventable diseases.

References

1. Siba PM. Papua New Guinea certified polio-free--complacency threatens dreams of eradication. PNG Med J. 2005;48(3–4):139–40.
2. Bauri M, Wilkinson AL, Ropa B, Feldon K, Snider CJ, Anand A, et al. Circulating vaccine-derived poliovirus type 1 and outbreak response - Papua New Guinea, 2018. MMWR Morb Mortal Wkly Rep. 2019;68(5):119–20.
3. Routh JA, Oberste S, Patel M. Poliomyelitis. In: Roush SW, Baldy LM, Hall MAK editors. Manual for the surveillance of vaccine-preventable diseases. 5th ed. Centers for Disease Control and Prevention; 2000. p. 1-11.
4. GPEI. Global Polio Eradication Initiative. [Internet]. 2019. Available from: http://polioeradication.org/polio-today/polio-prevention/the-virus/
5. Burns CC, Diop OM, Sutter RW, Kew OM. Vaccine-derived polioviruses. J Infect Dis. 2014;210(Suppl 1):S283–93.
6. Vashishtha VM, Kamath S. A Brief History of Vaccines Against Polio. Indian Pediatr. 2016;53:S20–7
7. Kavunga H, Simulundu E, Ahuka S, Mweene A, Muyembe JJ. Disease Trends and Characteristics of Circulating Vaccine derived Poliovirus Isolated in the National Reference Polio Laboratory from the Democratic Republic of Congo. Arch Med. 2017;09(04):1–5.
8. Duintjer Tebbens RJ, Pallansch MA, Kim JH, Burns CC, Kew OM, Oberste MS, et al. Oral poliovirus vaccine evolution and insights relevant to modeling the risks of circulating vaccine-derived polioviruses (cVDPVs). Risk Anal. 2013;33(4):680–702.
9. Pliaka V, Kyriakopolou Z, Markoulatos P. Risks associated with the use of live-attenuated vaccine poliovirus strains and the strategies for control and eradication of paralytic poliomyelitis. Expert Rev Vaccines. 2012;11(5):609–28.
10. Hall J, Ambang T, Asante A, Mapira P, Craig A, Schuele E et al. Poliomyelitis outbreak in Papua New Guinea: health system and health security implications for PNG and Australia. Medical Journal of Australia. 2019;211(4):161.
11. Gardner TJ, Diop OM, Jorba J, Chavan S, Ahmed J, Anand A. Surveillance to Track Progress Toward Polio Eradication — Worldwide, 2016 – 2017. MMWR Morb Mortal Wkly Rep. 2018;67;418-423. doi: http://dx.doi.org/10.15585/mmwr.mm6714a3
12. EPIWATCH. NHMRC Centre for Research Excellence Integrated Systems for Epidemic Response [Internet]. Available from: https://iser.med.unsw.edu.au/epi-watch
13. Yan SJ, Chughtai AA, Macintyre CR. Utility and potential of rapid epidemic intelligence from internet-based sources. Int J Infect Dis. 2017;63:77-87.

14. Vince JD, Datta SS, Toikilik S, Lagani W. Integrated package approach in delivering interventions during immunisation campaigns in a complex environment in Papua New Guinea: A case study. Vaccine. 2014.
15. World Health Organization-UNICEF. Estimates of Pol3 Coverage (2019). [cited 2019 Aug 14]; Available from: https://apps.who.int/immunization_monitoring/globalsummary/timeseries/tswucoveragepol3.html
16. WHO. Papua New Guinea Polio Outbreak Response, 2018. Manila, Philippines. World Health Organization Regional Office for the Western Pacific. 2019. Licence: CC BY-NC-SA 3.0 IGO. 2018; Available from: https://www.who.int/emergencies/disease-outbreak-news/item/02-July-2018-polio-png-en
17. United Nations Office for the Coordination of Humanitarian Affairs Data Exchange [Internet]. [accessed 28 January 2022]. Available from: https://data.humdata.org
18. Population | National Statistical Office | Papua New Guinea [Internet]. Nso.gov.pg. 2022 [accessed 25 January 2022]. Available from: https://www.nso.gov.pg/statistics/population/
19. Polio Outbreak Response in Papua New Guinea [Internet]. Unicef.org. 2018 [accessed 14 June 2022]. Available from: https://www.unicef.org/png/press-releases/polio-outbreak-response-papua-new-guinea
20. International Federation of Red Cross and Red Crescent Societies. Emergency Plan of Action Final Report. Papua New Guinea: Polio Outbreak. 2018; Available from: https://reliefweb.int/sites/reliefweb.int/files/resources/MDRPG009frf%282%29.pdf
21. Toikilik S, Tuges G, Lagani J, Wafiware E, Posanai E, Coghlan B, et al. Are hard-to-reach populations being reached with immunization services? Findings from the 2005 Papua New Guinea national immunization coverage survey. Vaccine. 2010;28(29):4673-9.
22. Morgan C, Saweri O, Larme N, Peach E, Melepia P, Au L et al. Strengthening routine immunization in Papua New Guinea: a cross-sectional provincial assessment of front-line services. BMC Public Health. 2020;20(1).

How to cite this article: M Raphael, DC Adam, AA Chughtai, A Kelly-Hanku, D Hutchinson, Y An Lai & CR MacIntyre. Poliomyelitis epidemic in Papua New Guinea, 2018. *Global Biosecurity, 2022; 4(1).*

Published: October 2022

Global Biosecurity is a peer-reviewed open access journal published by University of New South Wales.