Nigeria Will Become Polio-Free: Challenges, Successes, and Lessons Learned for the Quest to Eradicate Polio

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Abstract

In 1988, the World Health Organization (WHO) announced polio as the next eradication target. Since then the polio eradication effort has become one of the largest public-private partnerships successfully eliminating polio in all but three countries: Nigeria, Afghanistan, and Pakistan. Despite no reported cases in two years in Nigeria, on August 11, 2016, the WHO announced two new wild polio cases had been discovered in Northern Nigeria. While undoubtedly a setback, Nigeria has mobilized its immunization forces and will look to take heed of four key lessons learned during almost three decades of anti-polio efforts: 1) establishing and sustaining trust is critical to the success of eradication campaigns; 2) frequent, independent monitoring and evaluation are key to tracking the progress of an intervention and making modifications; 3) holding all actors accountable is essential to pushing an intervention forward and; 4) contextualized health initiatives are key in fighting polio and other diseases. These lessons will reinforce a cohesive, multilateral strategy that builds on past successes to secure a polio-free Nigeria.

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Preface

The near elimination of the hundred-year-old scourge of polio is among the greatest achievements of the global health movement. While public health authorities continue to battle occasional outbreaks, the sheer scale and effort made to date merits close study to understand how such progress was made as well as the challenges and trade-offs associated with getting to zero cases.

As part of our *Millions Saved* initiative, we have analyzed programs and policies that make a measurable difference to the health of people in low- and middle-income countries, highlighting the successful elimination of polio in Haiti after a period of resurfacing virus. Haiti was certified polio-free in 1994, but following a period of violence in the country, stagnating vaccination rates, and a lack of investment in sanitation efforts, polio resurfaced in 2000, and there were 8 confirmed cases between 2000 and early 2001. Haiti and its development partners responded vigorously after this initial disappointment: the government committed to control polio despite financial challenges; Haiti sustained and then improved surveillance; and the state effectively coordinated and cooperated with neighboring states and with other partners. By 2001, Haiti was polio-free again.

While the story of Haiti is instructive, the near-elimination of polio in Nigeria deserves special focus that is now possible thanks to this new paper by David Boyd and his co-authors. In the context of the most populous and second wealthiest country in sub-Saharan Africa, Nigerian authorities and their partners faced enormous obstacles – domestic terrorism and insecurity related to Boko Haram, large displaced populations, and general governance and leadership challenges. In spite of all this, Nigeria has reduced the number of polio cases to almost zero, a figure that has been verified rigorously and independently. While the paper did not come in time for inclusion of the Nigeria program in *Millions Saved*, the working paper will serve as a complement to the book's collection of global health successes.

Boyd et al's paper helps to understand the factors that drove success and what can be learned. While not all elements of the *Millions Saved* cases are included in this paper -namely information on the costs and cost-effectiveness of the polio elimination program in Nigeria, the work goes a long way to inform future global health efforts with its focus on accountability and independent measurement, packaging of polio with other more demanded interventions, as well as attention to the sociocultural acceptability of healthcare delivery. Impressively, the strategies and technology developed as part of the anti-polio campaign were also deployed effectively against an outbreak of Ebola in 2014, resulting in rapid containment and averting a potentially catastrophic outbreak in densely populated Lagos and Port Harcourt.

If all goes as planned, the authors posit that Nigeria will contain the last few cases of polio in the coming year, leaving only Afghanistan and Pakistan as non-eliminating countries. If elimination is achieved everywhere and sustained, the Global Polio Eradication Initiative estimates that 8 million paralytic poliomyelitis cases will be prevented by 2035. Truly millions saved.

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Re-emergence of Polio

In August 2016, two children in Nigeria's northeastern state of Borno were diagnosed with wild poliovirus. An additional case was reported in September, delaying the country's goal of polio-free certification to 2019 at the earliest (World Health Organization 2016d, Roberts 2016a). After years of work and hundreds of millions of dollars spent on polio elimination in Nigeria, the virus had nonetheless continued to circulate undetected for over four years (Roberts 2016a). This reemergence of the wild poliovirus shocked the global community, as Africa had celebrated two years of no new cases only weeks before the announcement.

While the Nigerian government has already initiated vaccination campaigns targeting millions of children in Northern Nigeria and surrounding countries, the factors that allowed polio to persist continue to pose significant barriers. The terrorist group Boko Haram (refer to Box 1) has created a regional humanitarian crisis and continues to prevent vaccination teams from reaching critical localities. Large displaced populations are continuously moving between cities and camps, hindering surveillance efforts and decreasing the ability to properly track children's vaccination status. Additionally, key Nigerian political leaders previously at the forefront of polio elimination have transitioned to different efforts or organizations (World Health Organization 2016a). The political will was further diminished and the vaccination campaigns faced stagnating levels of funding after two years without a reported wild poliovirus case (Roberts 2016b). While many of these issues have afflicted Nigeria for years, their simultaneous presence poses an unprecedented threat and highlights the seriousness of the current situation.

Despite these challenges, Nigeria will eventually be declared polio free. The current setbacks do not overshadow the major accomplishments made by the Nigerian government, the Bill & Melinda Gates Foundation (BMGF), the World Health Organization (WHO), UNICEF, the Centers for Disease Control and Prevention (CDC), Rotary International, and other partners of the Global Polio Eradication Initiative (GPEI). Their work over the past 30 years, particularly since 2008, has created structures and policies capable of eliminating the virus, even in the country's least stable areas. In fact, lessons learned from these experiences can be used to strengthen current efforts, which are already being designed to address the region's largest obstacles. By drawing on the collaboration, accountability, and leadership used in the past, Nigeria will contain the current cases and once again be removed from the polio-endemic list.

Background

Eight years after the landmark smallpox eradication , the WHO announced poliomyelitis (polio) as the next eradication target at the 41st World Health Assembly (Fenner et al. 1987). At the time, due to polio's identifiable nature, simple diagnostics, lack of an animal reservoir, and availability of affordable vaccines, it was an appropriate disease on which to focus the next eradication efforts. The eradication of polio is however, made difficult by the fact that multiple doses are required for full immunity, and that the disease can circulate asymptomatically (Mehndiratta, Mehndiratta, and Pande 2014). GPEI was established by the WHO, Rotary International, CDC, UNICEF, and BMGF with goals to eradicate polio

worldwide by 2000. It would become the largest internationally coordinated public health project in history, aiming to eliminate the presence of polio in over 350,000 people annually across 125 endemic countries (Duintjer Tebbens et al. 2010).

By 2014, intensive surveillance and multilateral eradication efforts had decreased polio incidence by 99 percent, with only 3 remaining endemic countries and 414 reported infections (Dowdle 1998). Polio remained endemic in Pakistan, Afghanistan, and Nigeria where conflict, political instability, remote populations, and poor infrastructure hinder global eradication. Nigeria was removed from the endemic list in September 2015, but within one year, the WHO reported the discovery of two new cases of wild poliovirus in the northern state of Borno (McNeil 2016). While this news may seem alarming to the global health community, Nigeria's previous successes with polio control, the strategies and public health infrastructure that it developed, and the lessons learned from those experiences put it in an excellent position to contain the current cases and move forward onto elimination.

Polio and its Global Burden

Polio, which stems from poliovirus, is a highly infectious disease that primarily affects the nervous system. It is transmitted via the fecal-oral route and most commonly affects children under five (Eggers 1999, Sabin and Ward 1941). While most infected individuals suffer from only minimal symptoms, 1 percent of cases result in permanent paralysis (Centers for Disease Control and Prevention 2016). This is of immense importance considering the recurrence of polio in Nigeria, as it highlights the difficulty in eradicating a disease that often has little to no sign of infection. Although polio is easily prevented through a series of vaccinations, no treatment currently exists for the disease (World Health Organization 2016c).

There are two current methods of effective polio immunization: oral polio vaccine (OPV) and inactivated polio vaccine (IPV). OPV, which contains live, weakened poliovirus, is a series of oral drops administered over a few weeks whereas as IPV does not contain the live poliovirus and is administered through three injections across several months. OPV is the vaccine of choice in Nigeria as it is less expensive and results in greater intestinal immunity (Centers for Disease Control and Prevention 2016). In extremely rare instances, the weakened viruses present in the OPV can mutate into strains capable of producing paralysis. These vaccine-derived polioviruses (VDPVs) only develop in 1 out of 2.7 million children receiving the OPV vaccine, a number exponentially smaller than the cases of paralysis prevented through the vaccination (Samant et al. 2007). However, due to the rare risk of VDPV, IPV is the preferred long-term prevention method (1997).

In addition to the health benefits for at-risk individuals, polio eradication has significant economic benefits since the disease places a large burden on healthcare systems, especially those in the developing world. Per the GPEI, the eradication efforts will prevent 8 million paralytic poliomyelitis cases by 2035, which will significantly increase the productivity of populations. Furthermore, this analysis estimated the global initiative, including a universal shift from OPV to IPV, was highly cost-effective when compared to a program of routine immunizations with net savings of around 42 billion dollars across the 104 GPEI-focused

countries (Duintjer Tebbens et al. 2010). These cost-savings persist even in the face of the GPEI's projected cost of an additional $8.5 billion ($7 billion as of 2015, and an additional $1.5 billion for 2016), to reach their goal of eradication by 2018 (Fernholz 2014, Global Polio Eradication Initiative 2016). Eradicating polio is ultimately cheaper than the alternative of containing the disease and responding to outbreaks, making these efforts financially beneficial to the global health field and its associated partnerships.

The challenges Nigeria faces in its campaign against poliovirus are problems faced by other polio-ridden nations. These challenges include a large youth population (44 percent under 15 years) (Demographic Dividend), an economic gap between the South and the substantially less-developed North (Akanbi 2011), regional religious differences between the predominantly Muslim North and primarily Christian South (Altman 2004), and the unstable health care systems of the neighboring countries (O'Reilly et al. 2011, Roberts 2004). The combination of these factors led to only 25 percent of the population being fully vaccinated in 2003, with a striking difference of 41-52 percent vaccination coverage in the South and 10-14 percent vaccination coverage in the North (National Population Commission (NPC) [Nigeria] and ICF International 2014). This paper details Nigeria's anti-polio efforts—whose successes and challenges provide valuable lessons for rapid containment of the 2016 cases—and highlights the leadership of Nigeria's public health system in significantly reducing polio throughout the country.

History of Polio Elimination in Nigeria

The Nigerian government, supported by the WHO and UNICEF, began its anti-polio campaign with the launch of the Expanded Program on Immunization (EPI) in 1979 (Keja et al. 1988). Through establishing fixed primary health care (PHC) facilities throughout the country and sharing tasks between the federal and local governments, vaccination coverage increased from 9 percent to 83 percent by 1984 (Sorungbe 1989). However, subsequent decentralization of the public health system shifted more vaccination responsibilities to local governments, who were unable to effectively meet the increased demands due to inadequate health infrastructure, funding, and resources (2016). Overall levels of immunization in Nigeria consequently fell to 26 percent by the mid-1990s, a 68 percent decrease in vaccination coverage (Renne 2012). The EPI changed its name to the National Program on Immunization (NPI) in 1996, with a new name came a renewed effort to provide greater support to immunization campaigns at the state and local government area (LGA) levels. The NPI collaborated with international organizations, via public-private partnerships, decreasing the number of African polio-endemic countries from 46 to 3, leaving Nigeria, Niger, and Egypt (Gautam 2005).

While increased support to the polio elimination efforts showed success, Nigeria faced four prominent challenges hindering the campaign's progress. Firstly, after a disastrous Pfizer antibiotic trial killed 11 children and left many disabled in Kano state, a large proportion of Northerners became suspicious of Western medicine and foreign interventions (Ahmad 2001). Secondly, the NPI implemented the polio campaign as a vertical health intervention. This created a backlash among locals who disagreed with prioritizing polio over more immediate life-threatening diseases such as measles and malaria, which people faced on a daily basis (Pate 2014). Third, in 2003, false accusations were made of the polio vaccine

containing anti-fertility elements, carcinogens, and HIV. These rumors ceased immunization activities in Kano and led to a resurgence of polio outbreaks across Nigeria eventually reintroducing the virus into eight other African nations (Renne 2006). And lastly, the campaign in Northern Nigeria has been continuously disrupted by the terrorist group Boko Haram (refer to Box 1), which has caused violence against polio workers, the disruption of immunization campaigns, and reduced access to health care and to immunization (Smith 2013, Omole, Welye, and Abimbola 2015). In addition, the group enacted targeted killing of healthcare workers, destroyed healthcare facilities, and has displaced large segments of the Northern population (Hamisu et al. 2015).

The NPI's willingness to enhance vaccination efforts with incentives such as bed nets and vitamin A supplements increased community support of the polio intervention (Sorungbe 1989). Improved immunization levels were short-lived before the NPI and National Primary Health Care Development Agency (NPHCDA) were combined in 2007, creating financial difficulties for the public health efforts. The poorly implemented merger left many incentives unsustainable and subsequently decreased the vital community participation in vaccination campaigns. As a result, Nigeria faced 801 wild polio cases in 2008, more cases than any other country in the world (Renne 2006).

In the face of this crisis, from 2008 to 2015 Nigeria implemented a wide range of innovative strategies to catalyze eradication efforts throughout the country. Considering the most recent cases discovered in 2016, we analyzed the most successful strategies utilized and comment on how they may be amended to achieve the goal of elimination in Nigeria and elsewhere.

NPHCDA Polio Strategy

Under new leadership, the NPHCDA committed itself to improving PHC in Nigeria where the primary concern was eliminating poliovirus. The leadership's first step was to fix the previously disjointed union of the NPHCDA and the NPI (Pate 2014). The functional organization now prioritized assessing where prior polio interventions failed and how to implement innovative methods to eliminate polio from Africa.

The NPHCDA developed a plan that focused on overcoming social, financial, and technical barriers facing immunization activities (Pate 2014). These issues included widespread distrust of government vaccination efforts, difficulties in securing funds, and discord between various health workers on the ground. The NPHCDA recognized that commitment from all levels-local, state, and national- was critical to the success of elimination. Therefore, priority was placed on maintaining accountability among leaders at each level.

Social

One of the primary objectives of the NPHCDA was to create political commitment to the polio elimination campaign. The signing of the Abuja Commitment in 2009 symbolized the political backing for the initiative and had governors pledge to provide active leadership to mobilize state and LGA administrations in order to vaccinate at least 90 percent of children (Pate 2014, Björkman and Svensson 2009). The politicians at every level were now liable for

vaccination coverage of their respective communities. These commitments were successful because the NPHCDA held the political leaders accountable and reprimanded those who did not fulfill their obligations.

The major social challenge faced was to rebuild community trust in the campaign. Suspicion of biomedicine, following the tragic Pfizer trial, and beliefs in the false accusations of harmful vaccinations still lingered, causing some parents to prevent health workers from vaccinating their families (Jegede 2007, Renne 2006). To counter these beliefs, community resources were utilized to gain social support and mobilization for the campaign. Traditional leaders became a vital resource as they had legitimacy in the eyes of many Nigerians (Pate 2014). An important victory under the new NPHCDA leadership was the mapping of the traditional leadership hierarchy, allowing the agency to identify key actors at each level. The NPHCDA ensured that these leaders understood the importance of and supported polio elimination for Nigeria's future. The NPHCDA also encouraged international support for these key actors to be effective in their regions and so they could be held accountable to their commitment. Major public-private partnerships, including the BMGF, Rotary International, and UNICEF, reinforced support for vaccinations by facilitating dialogue between community figures and Western donors (Guth 2010, UNICEF 2010, Nixon 2014). These combined efforts effectively established a deeper sense of responsibility in many traditional leaders to promote vaccinations in their respective communities.

Once the traditional leaders took ownership of the campaign, the elimination efforts reached a greater population and address individual concerns. The Sultan of Sokoto, one of Nigeria's most respected Muslim figures, established the National Task Team of Northern Traditional Leaders. This task team coordinated support for Supplementary Immunization Activities (SIAs) and built community demand by directing parents to immunize "every child, every time" (World Health Organization 2013a)(WHO, 2010). In addition, traditional leaders often attended public awareness shows called Majigi, a traditional social mobilization and communication tool that was used to educate and inform citizens about government programs (World Health Organization 2011). Majigi gave communities a chance to openly discuss concerns about vaccinations and empowered local leaders to produce films detailing the causes of polio and the proper prevention methods. Traditional institutions further increased their engagement with elimination activities by nominating four potential candidates for each available NPHCDA supervisor position. These leaders became a major driving force behind successful polio interventions in the remaining endemic states of Kano, Borno, Yobe, and Bauchi (Pate 2014).

Technical

Through the NPHCDA's assessment of previous polio strategies, it identified shortcomings in the accountability of vaccine workers. The frustrated and inconsistently paid vaccinators would often report higher numbers of vaccinated children than were completed and throw away remaining vaccines. To address the failings in paying vaccinators and false vaccination reports, electronic payment was implemented to directly pay vaccinators. The newly consistent pay motivated vaccinators to complete vaccination coverage and eliminated false reports. The NPHCDA also provided interpersonal skills training, which improved workers' ability to educate parents on the benefits of the vaccination, and NPHCDA leaders

frequently travelled to communities to reinforce the indispensable role of vaccinators in the elimination initiative (Pate 2014).

Another achievement that the new NPHCDA leadership implemented was identifying a gap in vaccination coverage along community borders. It partnered with BMGF to evaluate which settlements were reached during each vaccination campaign. This evaluation discovered inconsistent surveillance in 10-15 percent of settlements, which were overlooked because it was unclear who was responsible for vaccination activities in border regions between communities. Therefore, the NPHCDA and BMGF created geographical maps, known as microplans, to detail the placement of homes, markets, and other community establishments. By 2010, these geographic information systems (GIS) were used to target the 85 percent of the border regions that harbored some form of the poliovirus (Gammino et al. 2014). Eighty thousand settlements were mapped and vaccinators could reach children in the peripheral regions of wards (Barau et al. 2014).

Accountability

The Agency encouraged the polio elimination plan to focus on establishing mechanisms to hold local government leaders accountable for program performance. In 2011, lot quality assurance sampling (LQAS), a random sampling methodology to quickly assess vaccination coverage, and the use of GIS mapping were implemented as a robust independent way of evaluating the effectiveness of the polio initiative. These methods showed that 11 of the 18 LGAs had less than 70 percent vaccination coverage (Greenland et al. 2011). Considering this dismal information, Emergency Operation Centers (EOC) were established to hold all state and local actors accountable for their role and increase vaccination coverage, specifically in the regions identified as failing to meet at least 80 percent quality target for coverage. The EOCs presented information detailing each state's progress in increasing vaccination coverage which was presented at quarterly meetings with the president and state governors. If the vaccination coverage in a state was below the acceptable 80 percent target, then remedial measures were implemented for the state (Pate 2014). The NPHCDA worked with independent monitoring programs to pinpoint which regions needed to increase their efforts and then established a system to incentivize key figures within each region to work toward increased vaccination coverage.

Impact of Intervention Strategies

In 2015, as a direct result of the NPHCDA's polio intervention strategies, the WHO removed Nigeria from the global polio-endemic list, leaving only Pakistan and Afghanistan. Since the strategies were implemented, the percentage of high-risk LGAs that successfully reached 85 percent vaccination coverage increased to 64 percent and there was a 57 percent decline in national polio cases reported by 2013 (World Health Organization 2013b, Moturi et al. 2014). These continued results and efforts led to Nigeria's landmark achievement in 2015 where Nigeria reported zero new cases of wild poliovirus (Global Polio Eradication Initiative 2015). It was estimated that between 2014 and 2018, the Nigerian polio campaign will have averted an estimated 30,000-35,000 deaths (Global Polio Eradication Initiative 2013). Unfortunately, due to continued challenges in the North, the virus nonetheless lingered undetected until the three new cases of wild poliovirus were discovered in 2016 (McNeil 2016).

Current Challenges to Polio Elimination in Nigeria

Despite the monumental success of the NPHCDA's efforts, several remaining challenges allowed poliovirus to avoid detection and must be quickly addressed to prevent further transmission. Immunization activities in Northern states are still put at risk by Boko Haram. Security concerns over Boko Haram's presence prevented vaccinators from reaching multiple Northern villages over the last several years, and consequently up to 200,000 children in these areas may have never received any polio vaccine (McNeil 2016). Furthermore, the displacement of whole populations due to these threats of attacks interferes with disease surveillance. For example, stool samples were collected for less than 50 percent of acute flaccid paralysis cases in Borno and Yobe in 2014 (Hamisu et al. 2015). The combination of unimmunized children and inadequate surveillance allows the virus to spread silently, undetected. The three cases discovered in 2016 were found in areas under Boko Haram's control and the DNA sequencing confirmed that the viruses were related to the last seen case. This discovery suggested that the virus had been circulating, undetected in Northern Nigeria since 2011(McKenna 2016).

Another significant obstacle is reaching mobile populations in polio-endemic areas. As the Nigerian military regains territory from Boko Haram, many families have begun to leave temporary camps and travel back to their original homes. Northern Nigeria is also home to large nomadic groups (the Fulani people) that constantly move with livestock to find grass and water (McNeil 2016). These populations are difficult to track and even more difficult to vaccinate, as OPV doses are supposed to be administered at regular intervals over several weeks (Centers for Disease Control and Prevention 2016). Furthermore, both displaced persons and nomadic farmers regularly cross national borders, which could allow Nigerian polio strains to spread into other African countries (McNeil 2016).

Even after the current cases are contained, Nigeria also faces other operational challenges to have every child vaccinated. Firstly, as interventions shift from using OPV to IPV to prevent vaccine-derived polio infection, the higher cost and limited supply of IPV must be addressed. Making this switch is important for sustaining the campaign as IPV provides immunity against all three polioviruses without the risk of vaccine-derived infections (Patel and Orenstein 2016). Secondly, financial difficulties continue to compromise the availability of both vaccines and the payment for immunization activities in a timely manner (UNICEF Supply Division 2013). Although the polio elimination efforts have improved public health, there continues to be an underlying poverty in northern states, which further exacerbates these economic challenges (Hildebrandt 2014). Lastly, the political will and external funding to continue preventative methods must be sustained as the number of polio cases decreases. Donors have decreased their committed funding to eradicate polio which resulted in only 65 percent and 5 percent of the 2016 and 2017 estimated costs having secured funding (Global Polio Eradication Initiative 2013). These operational challenges combined with mobile populations and insecurities caused by Boko Haram continues to create challenges to Nigeria's efforts to eliminate polio.

Response to Remaining Challenges

To prevent the rediscovered strain from spreading, Nigeria began emergency polio vaccination activities in August 2016. These activities included door-to-door immunizations ("mop-up" targeting) in 5 LGAs which were recently under Boko Haram control and include Borno, where two of the recent cases were found (Odeyemi and Okafor 2016). A second response campaign was deployed in 18 Northern States in September 2016; these two immediate campaigns vaccinated over 28 million children. The Nigerian government has scheduled additional response campaigns to continue through the end of the year which will also cover surrounding regions such as the entire Lake Chad basin in Nigeria, Cameroon, Chad, and the Central African Republic (Odeyemi and Okafor 2016, McNeil 2016). The multinational effort aims to immunize thousands of children and prevent the introduction of polio into fragile neighboring states.

In response to Boko Haram, the campaign will receive protection and support from military units of all five countries (McNeil 2016). In the short-term, in security-compromised states such as Kano, Borno, and Yobe, vaccinators can continue to make use of 'Hit and Run' teams, mobile units composed of extra teams of vaccinators that can quickly get into and out of dangerous zones. This strategy—originally part of the 2015 Nigeria Polio Eradication Emergency Plan—shortens mass immunization days from four to just one or two days, allowing the workers to reach populations in areas where Boko Haram poses a threat. This tactic can be combined with the 'days of tranquility' where the polio vaccinators negotiate with Boko Haram to allow vaccinations to occur on specific days (Roberts 2016a). While the previous strategies work well during lulls in fighting, during wartime, soldiers and military personnel could be trained to give oral polio vaccine. Another tactic that has worked in recent years is utilizing respected elderly women residing within inaccessible communities as vaccinators. The communities' value and trust in these individuals allows them to educate the populations on the necessity to vaccinate their children and promote vaccinations in hard-to-reach areas (National Primary Health Care Development Agency 2013).

In the long-term, efforts should be focused on vaccinating the refugee populations. To improve vaccination coverage among mobile populations, the campaign plans to set up "health camps" which will provide families OPV in addition to food, vitamins, prenatal care, and other childhood immunizations. Experts believe that this wide-range of benefits will attract migratory people who are unlikely to visit health clinics just for polio vaccines. In addition, some vaccinators are constantly "on call" and equipped to immunize nomadic children when their families gather at markets, festivals, and outposts; other polio workers travel with veterinarians that check on nomads with livestock (McNeil 2016). Furthermore, an established practice called "firewalling" will continue to target LGAs surrounding Borno by distributing vaccines at crossing points, ensuring high levels of coverage in border regions (National Primary Health Care Development Agency 2013).

To reach remaining pockets of children chronically missed in previous vaccination cycles, in 2014 Nigeria introduced the practice of Directly Observed Polio Vaccination (DOPV). DOPV is essentially the administration of OPV to children outside the household under watchful supervision of vaccination teams within the framework of the Immunization Plus

Days. The strategy was originally implemented to counter the few vaccinators that colluded with parents to finger mark children without actually dispensing 2 OPV drops, thereby improving coverage of children who were constantly absent during vaccination rounds. DOPV allows vaccination teams and their supervisors to target children outside the home, on streets, and even at social events. In addition to the direct observation, children and parents are given incentives such as milk sachets, soap, candies and whistles. The DOPV approach was scaled up in September 2014—increasing coverage by 20 percent compared to the previous month—and will remain a key strategy to achieve elimination in Nigeria (World Health Organization 2014a).

Nigeria has also implemented cost-effective measures to eliminate the financial barriers to distributing IPVs. Reducing the number of vaccine doses, using adjuvants (compounds that augment the immune response to the vaccine), and introducing seed strains all increase the feasibility of using IPV for polio vaccine coverage in Nigeria (Kreeftenberg et al. 2006, Resik et al. 2010). In addition, current polio strategies include horizontal activities to continue the prioritization of Nigeria's overall health care system (Nguku et al. 2014). Importantly, Nigeria's improved health infrastructure can equip the country to more efficiently respond to a broader range of public health concerns, which was proven in 2014 with Nigeria's swift containment of the Ebola outbreak. Satellite-based cutting-edge GPS technology along with epidemiology work developed during the polio eradication program were repurposed for real time contact tracing to link Ebola cases. Religious and traditional community leaders were involved early on to sensitize citizens and awareness campaigns developed during the polio campaign were used to encourage early reporting for symptoms. The successful strategies and technology developed during polio interventions became a model utilized in detecting the 19 Ebola cases, decreasing fatality rate from 70 percent to 40 percent and containing a global public health emergency (World Health Organization 2014b).

Lessons Learned

Nigeria's current challenges and past successes of polio elimination offer key lessons in the areas of trust, monitoring and evaluation, accountability, and flexibility. These lessons can aid in the containment of the current polio cases in Nigeria, serve as a model for Pakistan and Afghanistan in their fight against polio, and provide strategies applicable to different health challenges, contexts, and scenarios.

Lesson 1: Establishing trust is critical to the success of eradication campaigns.

Eradication campaigns are founded upon mutual trust and the firm belief in reliability, efficacy, and transparency between all actors and the community. Initially, one of the largest barriers to progress in the polio eradication efforts was the lack of support from the Northern community. The combination of the ill-fated Pfizer trial and false rumors of negative health outcomes caused by the vaccines bolstered sentiments of distrust. However, the Nigerian government addressed these concerns by utilizing increased community buy-in. By treating traditional leaders as partners and educating populations about the campaign, the

Ministry of Health successfully established trust with Northern Nigerians. Understanding the concerns and needs of the most disease-burdened communities allows an eradication program to attain trust and work towards being culturally competent. This trust will be essential in regaining polio-free status within the next few years.

Lesson 2: Frequent, independent monitoring and evaluation are key to tracking the progress of an intervention and making modifications.

This strategy highlighted the successful use of sampling methods and technologies such as LQAS and GIS by independent monitoring and evaluation teams. These methods were used to track progress during the intervention, allowing geographical areas of concern to be pinpointed and addressed. In doing so, parts of Nigeria below immunization standards once entirely overlooked were accounted for and vaccinated. This tangible data could be used not only to compel state leaders to make polio vaccination a priority but also to ensure cases do not reemerge in post-intervention countries where polio has been eliminated. Finally, LQAS and GIS data can also be utilized to track progress in the fight against other rampant infectious diseases. The Nigerian campaign demonstrates how data can be used to prove the effectiveness of an intervention to stakeholders and to encourage future support from politicians and private-public partnerships. As Nigeria looks to regain its polio-free status, strong monitoring and evaluation methods will prove essential to identifying remaining vulnerable areas and properly allocating resources. Setting up "health camps" to provide OPV and other resources to nomadic families as well as placing vaccinators "on-call" will aid in vaccinating the migratory populations displaced by violence.

Lesson 3: Holding all actors accountable is essential to pushing an intervention forward.

The keystone of the previous success of the polio intervention was accountability. On the most fundamental level, transparency and clear communication were maintained with the people of Nigeria. This included being forthright with the reality, though rare occurrence, of circulating vaccine derived poliovirus (cVDPV) and stressing the importance the individual's responsibility for vaccination. In addition, surveillance and monitoring were separated from the government and done by an independent monitoring group. The separation eliminated bias and false reporting, thereby rendering the data collected as concrete evidence for holding each key player, including government officials, accountable.

In a broader sense, state and national leaders were accountable to their regions and international support was maintained to ensure effective health initiatives. Technology was utilized on the state level and policy and legislative changes on the national level to incite newfound commitment to improve underperforming areas. On the international level, the EOC applied pressure on the global community to ensure continued support. This stemmed from key public-private partnerships between the Nigerian government and organizations such as the Bill and Melinda Gates Foundation, WHO, UNICEF, Rotary International, and

the CDC (Pate 2014). These actors were held accountable for providing funding, vaccines, and technical support while agencies in Nigeria were responsible to ensure delivery of the vaccinations on a schedule set by these international organizations. On all levels, accountability was key to propelling the initial polio intervention toward success by increasing the efficiency, transparency, credibility, and communicative needs of the elimination efforts. Given the recent reemergence of polio in Nigeria, accountability will be equally important in the effort to ensure proper caution and sustain vigilance to promote adequate intervention follow-up and maintenance.

Lesson 4: Contextualized health initiatives are key in fighting polio and other diseases.

The challenges and successes of implementing the GPEI in Nigeria highlight the importance of country-specific health initiatives. The initial attempts to create a "one-size-fits-all" plan undermined the diversity of challenges facing the elimination initiatives within Nigeria. The campaign ultimately harnessed existing resources and remained flexible when addressing new challenges.

One success of the interventions in the North was the addition of other health incentives into the elimination plan. Parents considered malaria, cholera, and typhoid fever more devastating to their children than polio. Therefore, incorporating bed nets and vitamin A supplements into mass immunization days relieved parents' concerns and gained their trust that the government wanted the best for the communities' needs as well as the nation's. This approach has been utilized in mass immunization "health camps" in the North (Moser 2014). This shift from a vertical-approach to a horizontal-integration became instrumental in building Nigeria's overall healthcare system.

Another important aspect of the initiative's journey is the creative adaptation of pre-existing structures to vaccinate hard-to-reach communities. Leaders in the NPHCDA leveraged their political experience and cultural identity as Northerners to help facilitate the communication with religious leaders, allowing them to gain the support of previous outspoken and influential disbelievers in the polio vaccine. Consequently, opposition to the vaccination program reduced, allowing the initiative to move forward.

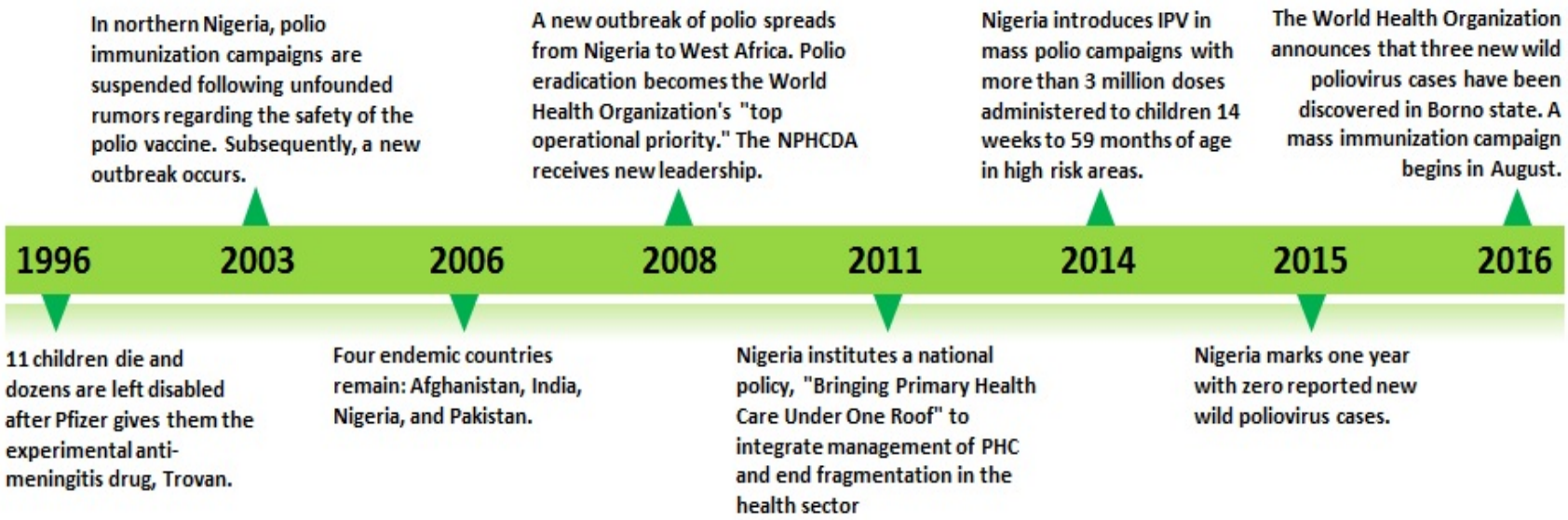
The success of any health initiative hinges on its incorporation and adaptation within a complex and constantly evolving landscape. For example, the established polio infrastructure was used to tackle the current Ebola outbreak that travelled to Nigeria in 2014 (Pate 2014). This exemplifies how the establishment of the basic health infrastructure could adapt to aid in tackling infectious and non-communicable diseases. Considering the recent outbreaks, contextualized strategies have never been more important. In the short-term, the use of soldiers and border-teams provides a unique solution to the vaccination of displaced and war-torn populations. In the long-term, settlements and refugee camps need proper sanitation and nutrition to maintain the general health and well-being of these mobile populations. The barriers and strengths to a health initiative can vary in space and in time, but it is ultimately up to global health actors to creatively target diseases in a country-specific manner.

Conclusion

While the discovery of new polio cases in Nigeria in 2016 came as disappointing news to the global community, the Nigerian government has allocated and received financial resources to mobilize its immunization forces to fiercely target, combat, and eliminate polio again. The challenges posed by hard-to-reach migrant populations and insurgency groups like Boko Haram have created substantial barriers to achieving this outcome. However, Nigeria has a wealth of valuable lessons from its past polio interventions and the revamping of its primary health care system to inform its current efforts to attain success. Through strengthening its monitoring and evaluation methods, maintaining trust in communities, continuing to ensure accountability, and tailoring initiatives to differential political and demographic contexts, the Nigerian government can bolster the impact of its short-term emergency polio immunization campaigns.

As a global community, we face an impending responsibility to support efforts toward a polio-free Nigeria as well as turn our attention toward the other two remaining endemic countries: Afghanistan and Pakistan. Some of the challenges Nigeria currently endures may persist, but with continued prioritization of polio elimination and external support, Nigeria will once again be added to the polio-free list. Now is the most critical time for global support to eradicate polio once and for all.

Figure 1. Timeline of Polio Eradication Efforts in Nigeria



Box 1: Boko Haram's Presence in Nigeria

Boko Haram ("Western education is forbidden") is Nigeria's primary insurgent, militant Islamist group. Although their presence in Northern Nigeria was established years' prior, the sustained attacks and violence against the state and police began in July 2009. A confrontation between police and Boko Haram led to the police killing over 800 people and executing, without trial, any supporter or sympathizer of Boko Haram (Walker 2012, Sergie and Johnson 2014). Since this incidence, Boko Haram has regularly attacked Nigeria's police, military, politicians, schools, public institutions, and civilians leading it to be considered a foreign terrorist organization by the U.S. Department of State (Sergie and Johnson 2014).

The violence of Boko Haram has limited Nigeria's ability to eradicate polio. The WHO estimates that 72 percent and 60 percent of health centers have been damaged in Yobe and Borno respectively causing a significant challenge for health workers to deliver not only polio vaccinations but other basic health services (World Health Organization 2016b). Additionally, the violence has created huge populations of refugees. These migrating populations are difficult to vaccinate, and their displacement has led to malnutrition and limited basic health care, exacerbating the already dire situation. While efforts may be underway to thwart Boko Haram's immediate effect on the polio campaign, including hit-and-run tactics of vaccinators and training soldiers to provide OPV doses, long term solutions must include regaining control of the region. The inaccessible settlements in the North allow polio to circulate undetected, increasing the risk of exportation to neighboring Local Government Areas (LGAs) and other African nations (Bigna 2016).

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