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THE GLOBAL POLIO ERADICATION INITIATIVE: ACHIEVEMENTS, CHALLENGES, AND LESSONS LEARNED FROM 1988-2016

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CONTENTS

ABBREVIATIONS

AFP	Acute Flaccid Paralysis
bOPV	Bivalent Oral Polio Vaccine
BMGF	Bill and Melinda Gates Foundation
CSIS	Center for Strategic and International Studies
cVDPV	Circulating Vaccine-derived poliovirus
DG	Director General
EC	European Commission
EOC	Emergency Operations Centre
EPI	Expanded Programme on Immunization
GEAP	Global Emergency Action Plan
GPEI	Global Polio Eradication Initiative
IHR	International Health Regulations
IMB	Independent Monitoring Board of the Global Polio Eradication Initiative
IPV	Inactivated Polio Vaccine
KfW	Kreditanstalt für Wiederaufbau
NEAP	National Emergency Action Plan
NID	National Immunization Day
OPV	Oral Polio Vaccine
PEESP	Polio Eradication Endgame and Strategic Plan
PHEIC	Public Health Emergency of International Concern
POB	Polio Oversight Board
PPG	Polio Partners Group
SIA	Supplementary Immunization Activities
TAG	Technical Advisory Group
tOPV	Trivalent Oral Polio Vaccine
UN	United Nations
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Programme
UNF	United Nations Foundation
UNSC	United Nations Security Council
US-CDC	U.S. Centers for Disease Control and Prevention
VDPV	Vaccine-derived polio virus
WHA	World Health Assembly
WHO	World Health Organization
WPV	Wild poliovirus

FOREWORD

The Global Polio Eradication Initiative (GPEI) was launched in 1988 with a target date of 2000 for completion. Sixteen years after that target was missed, front-line workers in some of the world's most dangerous environments strive to complete the task. Success is close at hand and, if achieved, the world will reap great rewards – lives protected from a crippling disease and a legacy that can benefit health systems and future global health programmes. Yet, the costs of such failure would be very high. Consequences will include the added disease burden, the financial implications of continuing worldwide vaccinations, surveillance and control, and the deterrent effect that such a setback might have on ambitions for other global health initiatives.

In view of the benefits that polio eradication would represent as a global public good, the Global Health Centre at the Graduate Institute Geneva has undertaken a research project to better understand the social and political barriers to polio eradication. This research project, comprising expert interviews and several high-level policy dialogues, has culminated in a comprehensive policy analysis of the political factors underpinning global polio eradication efforts, with a particular focus on European actors. The core research findings and analysis were complemented by a desk review of documents, policies and academic literature pertaining to polio and the eradication of diseases more broadly. Given the background relevance of the literature, this report offers a succinct, primarily descriptive, summary of key documents, articles and reports in an effort to map the complex journey of the GPEI and its partners in polio eradication efforts. It therefore contextualizes the main project report.

The literature describing and analysing the processes behind the polio eradication efforts provides important perspectives on the successes, lessons learned and barriers yet to be overcome by the GPEI. The following review covers sources up to October 2016, including reports to and resolutions passed by the World Health Assembly (WHA) and the World Health Organization (WHO) Executive Board (EB), together with documents from other special WHO meetings, including those of its Strategic Advisory Group of Experts on Immunization (SAGE), the GPEI and speeches made by the WHO Director General (DG), as well as peer-reviewed and grey literature, and press reports. In line with the project's overall direction, the review focuses on the roles played by European actors.

1. INTRODUCTION

1.1 Polio eradication in 2016: nearly there?

Since it was initiated in 1988, the GPEI has grown to be the largest international health effort in history (Aylward & Linkins, 2005). It has advanced considerably towards the goal of polio eradication. With the technical means to eradicate polio at hand, the GPEI's Polio Eradication and Endgame Strategic Plan 2013-2018 (PEESP) initially aimed for a world certified to be polio-free by 2018. Progress has been uneven with waves of success and periods of setback.

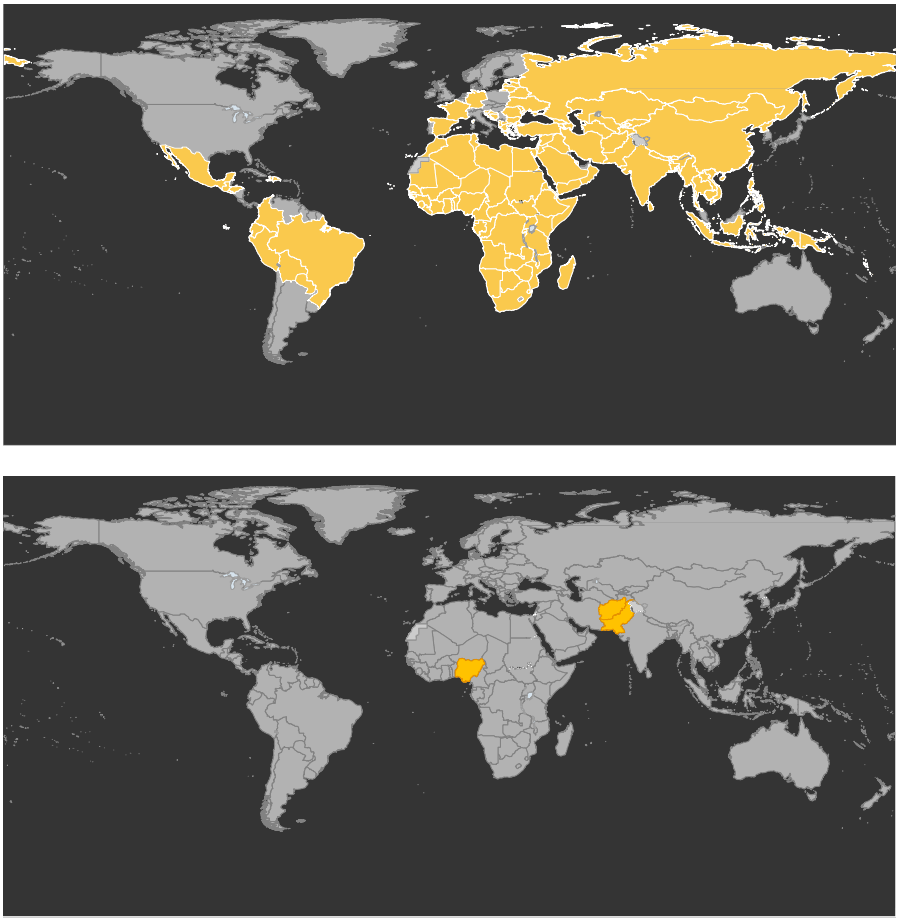
Due to delays in achieving polio eradication in the then remaining endemic countries (Afghanistan and Pakistan), the target was again delayed, projecting interruption of wild poliovirus (WPV) transmission in 2016, and global certification in 2019. This has resulted in a requirement for an additional US$ 1.5 billion in funding (GPEI, 2015h). As of 30 November 2016, 34 polio cases had been reported during the year (compared with 44 at the same point in 2015), including 23 WPV cases in Afghanistan and Pakistan (44 at the same point in 2015) and three circulating vaccine-derived poliovirus (cVDPV) cases in Lao People's Democratic Republic (PDR). A setback was seen in Nigeria, which had seen its previous last case in July 2014, when three new cases of WPV occurred in July-August 2016 (WHO, 2016g).

While it is difficult and costly to complete the eradication of polio, there is no reasonable alternative. The costs of failure would be very high (GPEI, no date [n.d.]-a). Reaching the last cases necessitates overcoming major remaining obstacles that are not simply technical or economic but include cultural, political, religious, security and social factors.

Box 1: What is polio?

Poliomyelitis is an infection caused by any of three strains (known as types 1-3) of wild polio virus (WPV). It is frequently asymptomatic and therefore most often recognizable by the onset of acute flaccid paralysis (AFP), occurring in less than 1% of infections and primarily affecting children under the age of five. There is no cure and prevention is the only approach available, with oral polio vaccine (OPV), which contains live attenuated virus, or injectable inactivated polio vaccine (IPV). On rare occasions the use of OPV can itself lead vaccine-associated paralytic polio (VAPP) or, by combining with certain strains of another virus, to cases of polio infection due to circulating vaccine-derived polio virus (cVDPV). For those not familiar with technical aspects of polio and the vaccines that have been developed to prevent it, a Technical Annex at the end of this report provides a brief guide.

Box 2: Progress of polio eradication: polio-endemic countries in 1988 and 2017



1.2 Polio eradication targeted in 2016: but not the end of the story…

Even if all cases of polio worldwide ceased in 2016, the eradication initiative could not simply be shut down forthwith. Several strands of activity will need to be continued for a number of years:

- **A double transition** of the vaccines used is under way. In April 2016, more than 150 countries using Oral Polio Vaccine (OPV) switched from one based on three different wild strains of live attenuated virus to a vaccine based on two wild strains, as WPV type 2 was eliminated in the wild in 1999 (Friedrich, 2016; WHO, 2016e). Later, OPV will be replaced by an injected IPV to eliminate the risk of cVDPV cases. Inactivated polio vaccine (IPV) injections are more expensive and require more trained health workers, while their production requires large scale growth of WPV in well-controlled containment facilities.
- **Maintenance of vaccination and surveillance programmes** and of rapid response capabilities will be essential for many years, to ensure that polio does not reappear from sources such as carriers, contaminated bio-samples or inadequate containment at production facilities.
- **The polio assets built up during the polio eradication initiative** include trained personnel, organizational structures and management systems, cold chains, surveillance and laboratory systems and knowledge. These should be applied for the benefit of health globally – strengthening national health systems and assisting the move towards universal health coverage, now a target of the UN's Sustainable Development Goals (SDGs) for 2030. The learning about effective governance, financing, strategic planning and management of large-scale health programmes and practice of health diplomacy can have important benefits for future global health initiatives, including possible new disease eradication efforts.

2. THE GLOBAL POLIO ERADICATION INITIATIVE

2.1 Introduction

The resolution launching the GPEI at the World Health Assembly (WHA) on 13 May 1988 declared *"the commitment of the WHO to the global eradication of poliomyelitis by the year 2000"* (Forty-first World Health Assembly, 1988). It highlighted the importance of ***"political will of countries"*** and ***"investment of adequate human and financial resources"***. It also recognized the importance of linkages between eradicating polio and strengthening other immunization services – in particular, the Expanded Programme on Immunization (EPI) – and health infrastructure and primary health care and the need for the WHO's Director General (DG) to seek additional resources from extra-budgetary contributions. Overall progress of the GPEI is depicted in Box 2 above, showing that despite tremendous successes, eradication has remained an elusive goal in global health.

This chapter provides a chronological overview of the GPEI since its initiation nearly three decades ago. It begins with a discussion of the key actors and structure of the Initiative, before considering periods of success and failure for global polio eradication efforts.

2.2 Key Actors

The GPEI partnership initially involved WHO, the United Nations Children's Fund (UNICEF), Rotary International and the US Centers for Disease Control and Prevention (US-CDC). Partners joining later included the Bill and Melinda Gates Foundation (BMGF), United Nations Foundation (UNF) and others. The GPEI is a complex but flexible partnership. Box 3 highlights some of the key polio actors and provides details on their roles. The heads of the core partner agencies are closely involved in the programme's management, and the Polio Oversight Board (POB) and global Polio Partners Group (PPG) have been created to improve the Initiative's capacity to carry out its work during the final phase.

Rotary International has worked since 1985 to help control polio worldwide, following efforts that began in 1979 by the then President of Rotary, Clem Renouf, John Sever of the US National Institutes of Health and Dr Albert Sabin, the developer of the oral polio vaccine, to

champion the cause (Hanf & Grahl, 2015; Range, 2014). Rotary has been involved in the GPEI from the outset. In 2007, the organization entered into a partnership with BMGF, through which BMGF matched and supported Rotary's contributions to polio eradication. The distinct and diverse nature of Rotary's worldwide membership and its fundraising capacities have been major assets.

US-CDC provides scientific expertise to many polio eradication programmes and activities, assisting in planning and monitoring polio surveillance and immunization, housing a WHO Global Specialized Laboratory and providing technical and programmatic assistance to the global polio laboratory network (US Centers for Disease Control and Prevention, 2015). Members of its Stop Transmission of Polio (STOP) teams have participated in assignments in 66 countries.

Polio eradication is a top **BMGF** priority and as a major supporter of the GPEI, the foundation contributes technical and financial resources to its GPEI partners in many areas (Bill and Melinda Gates Foundation, n.d.). As a private foundation, BMGF has the flexibility to take big risks and to make non-traditional investments that can lead to valuable programme improvements.

UNICEF plays a key role in the procurement and distribution of polio vaccines, both for supplementary immunization activities (SIAs) and routine immunization (RI) (GPEI, n.d.-e). UNICEF supports National Immunization Days and mop-up campaigns, as well as contributing to the development of communication strategies, action plans and logistics provisions at national and subnational levels. The organization contributes actively to advocacy and resource mobilization at the global level, in addition to community-based strategies to improve local acceptance of GPEI activities and vaccinations.

WHO coordinates the major planning, strategies and administrative management of the GPEI. As the governing body of WHO, the WHA provides the highest level of governance for the GPEI and therefore for global polio eradication and its partners in general (GPEI, n.d.-b). WHO Regional Committees, particularly those with countries where infection still occurs, also allow for more context-specific discussions. Polio or polio eradication efforts are frequently included as agenda items for both for the WHA and the EB, with discussions based on reports from the Secretariat or the DG. In relation to its oversight of the GPEI, WHO also calls on the work of the SAGE and the Global Commission for the Certification of the Eradication of Poliomyelitis (GCC). It also has responsibility for the 2005 International Health Regulations (IHR), which formed the basis for the declaration of the international spread of WPV as a Public Health Emergency of International Concern (PHEIC). The DG is also often called on to act through WHA resolutions and can play a catalytic role for the GPEI, as was the case in 2007 when she convened the Urgent Stakeholder Consultation on interrupting WPV transmission.

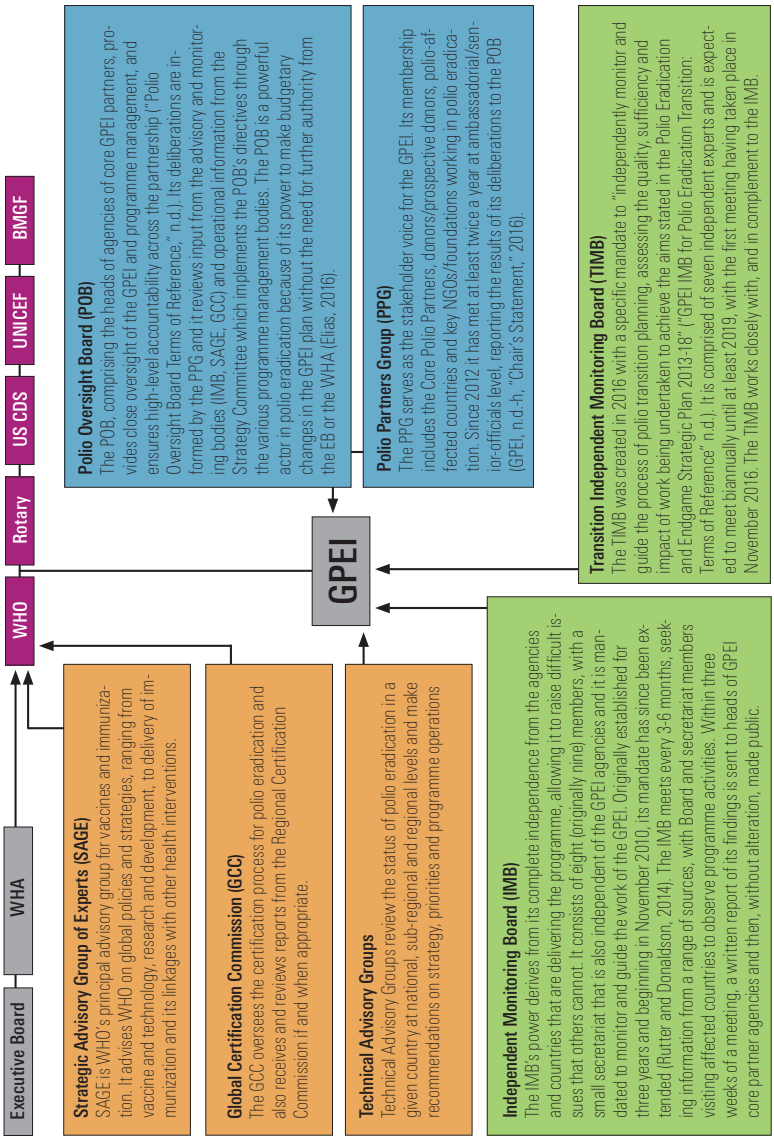
Established without precedent in global health programmes, the GPEI's **Independent Monitoring Board** (IMB) deserves particular mention. The IMB has been an important source of commentary and guidance for the GPEI. In a 2014 paper, the IMB's Chair, Sir Liam Donaldson and Paul Rutter cite an earlier IMB comment that *"Stopping transmission in over 100 countries is no small feat. We deeply respect this. But this is not the aim. The aim is to reach 100%, and on that count the programme has not been fit for purpose"* (Rutter & Donaldson, 2014, S17). From early 2011, the IMB considered that the GPEI needed to alter its approach fundamentally and that it would miss the next target date (2012) for stopping polio transmission. The IMB has made wide-ranging recommendations to improve the Initiative's performance.

The work of the IMB was reviewed by Bristol and Millard (2015) at the Center for Strategic and International Studies (CSIS). They noted the reliance of the IMB on its individual members, particularly its Chair. There was originally concern about the IMB's lack of expertise specifically related to polio eradication; however, the Board's broad range of global health knowledge has allowed it to address issues that are generally outside the GPEI's epidemiological approach. The authors also referred to the IMB reports as being well informed, well written and relevant to the programme's challenges; and considered them *"a constructive balance between stern and supportive"* (Bristol & Millard, 2015). They also pointed out areas for improvement, including improving connections to in-country contexts and the fact that there is sometimes a lack of hard data to back up the IMB's assessments. Overall, the CSIS report concludes positively that *"the IMB has been a solid contributor to many of these successes. As global partnerships increasingly become the norm for large-scale health initiatives monitoring mechanisms modelled after the IMB could, under the right circumstances, improve the effectiveness and efficiency of global health management"*(Bristol & Millard, 2015, 13).

In recent years, there has been increasing attention paid to the legacy of polio eradication and how to best facilitate the transitioning of polio related assets into national and global health systems. To drive and guide the planning of this critical process, a **Transition Independent Monitoring Board** (TIMB) was set up in November 2016 (GPEI, n.d.-g).

The GPEI website also lists **other partners**, contributing in different ways to the work of the Initiative. They include the United Nations Foundation (UNF) and other private foundations, development banks (e.g. World Bank), donor governments, the European Commission (EC), humanitarian and nongovernmental organizations (e.g. the International Red Cross and Red Crescent societies), corporate partners (e.g. Aventis Pasteur, De Beers) and volunteers in affected countries (GPEI, n.d.-e).

Box 3: Key Actors in Polio Eradication Efforts



2.3 Towards 2000: making progress, but missing the target

The timeframe of achieving eradication by the year 2000 proved to be highly over-optimistic. The DG reported to the 1999 WHA that global coverage for polio eradication was 80 percent of the world's infants (WHO, 1999). Eighty-nine countries (including all endemic countries except the Democratic Republic of the Congo [DRC] and Sierra Leone) were conducting national immunization days (NIDs). At the prevailing rate of progress, it was expected that polio would be *"eradicated globally by the year 2000 or shortly afterwards"*. However, there were still approximately one dozen endemic countries remaining, including some in conflict where eradication activities depended on the successful negotiation of truces. The financing of polio eradication was also a critical issue. Initially countries paid 80-90 percent of total costs, but poor infrastructure and health resources in remaining affected countries meant that a high percentage of eradication costs going forward would have to be met from external sources. WHO estimated that a total of US$ 850 million was needed from external sources over three years, with the shortfall at the time being US$ 370 million.

A resolution from the January 1999 EB to the WHA urged Member States to mobilize the necessary finance and accelerate diverse eradication activities of all partners to *"facilitate acceleration of the initiative to eradicate poliomyelitis during the critical period 1999 to 2001."* This extended the target date beyond the year 2000 (WHO 103rd Executive Board Session, 1999).

2.4 2001-2008: mixed progress and a sliding target date

The target date for eradication was moved to 2005 and meanwhile, as reported to the 2002 WHA, efforts continued to intensify the impact of programmes (WHO, 2002). In 2000-2001, countries in West Africa had synchronized their NIDs, as also continued to be the case in Afghanistan, Iran and Pakistan. Large un-earmarked contributions to the programme were made by the Netherlands and the United Kingdom (UK) as well as the BMGF and UNF, totalling US$ 308 million, with additional contributions through multilateral and bilateral channels. However, a funding gap of US$ 275 million was projected to the end of 2005. The WHO was also working to ensure that lessons learnt from polio eradication and the infrastructure were used to improve delivery of other immunization services and surveillance for other diseases of public health importance.

By 2004, Nigeria, India and Pakistan accounted for 93 percent of cases (WHO, 2004). At an emergency meeting of health ministers from affected countries, the Geneva Declaration for the Eradication

of Poliomyelitis (2004), was adopted, through which participating governments committed to direct national oversight of all eradication activities. A new **Global Polio Eradication Strategic Plan for 2004-2008** was launched, aiming to interrupt poliovirus transmission in 2004-2005 (GPEI, 2004).

Unsteady progress was reported in 2005 and 2006, while a funding gap between budgeted plans and income or commitments remained alongside repeated calls by the WHA for greater effort (Fifty-ninth World Health Assembly, 2006; WHO, 2005). In February 2007, DG Margaret Chan convened an Urgent Stakeholder Consultation on interrupting WPV transmission (WHO, 2007c). Even though the task ahead looked *"more promising than ever before"*, without *"an immediate surge of commitment, the virus [might] win"*. The meeting reaffirmed the case for completing eradication, but there were very serious problems. With the original deadline missed, there was increasing scepticism and questions were raised about the efficacy of the vaccine, access, security, poverty, funding and competing health programmes. The DG warned that they would not be forgiven for failing to finish the job. Donor community commitment was absolutely vital at a time when new data showed that *"over a 20-year period, every proposed option for controlling polio will cost more, in human suffering and dollars, than finishing eradication"* (WHO, 2007c).

The *'intensified polio eradication effort'* for 2007-2008, launched in February 2007, attracted strong financial commitments, including from India, Nigeria and Pakistan (WHO, 2007a). As reported to the 2007 WHA, these three countries and Afghanistan had still not interrupted WPV transmission and accounted for 94 percent of all new cases (WHO, 2007b). To reduce international polio transmission, the EB recommended that all travellers from affected areas should be fully vaccinated before travel (WHO, 2007b). A process was also presented at the WHA to minimize and manage the risks of re-emergence of polio after eradication (Sixtieth World Health Assembly, 2007; WHO 120th Executive Board Session, 2007).

Significant further progress in the endemic countries and an intensification of efforts in challenging areas of Afghanistan, India, Nigeria and Pakistan were reported by the Secretariat to the 2008 WHA (WHO, 2008). The 2008 WHA resolution urged affected Member States to engage all levels of political and civil society to reach every child during supplementary immunization activities (SIAs), with the necessary financial resources made available rapidly (Sixty-first World Health Assembly, 2008). The DG was also requested to develop a new strategy to reinvigorate the fight to eradicate polio and also submit proposals for review by the EB *"for a mechanism to mitigate the risk of the reintroduction that does not involve amending the 2005 International Health Regulations (IHR) or developing another binding instrument"*.

2.5 Intensification in 2009-2013

By 2008, it became clear that 'business as usual' was not going to bring about polio eradication. The multi-year GPEI planning was temporarily replaced with a one-year **2009 Programme of Work** (GPEI, 2009, 2010a). During this period, the major barriers to interrupting WPV transmission in each of the remaining endemic areas were examined through an **Independent Evaluation**, which published its final report in October 2009 (Mohamed, Ndumbe, Hall, Tangcharoensathien, & Wright, 2009). The evaluators gained an impression that *"things had stalled"* despite impressive progress in individual sectors. They noted a variety of contributing factors and made country-specific recommendations regarding diverse local issues needing to be addressed.

The **GPEI Strategic Plan 2010–2012** projected that cessation of all WPV transmission would occur in 2012 (GPEI, 2010c). The Plan built on the 2009 Programme of Work incorporating new initiatives to scale-up the approaches needed to address the remaining operational challenges (GPEI, 2009, 2010c; WHO, 2009). Individually-tailored strategies were adopted for specific circumstances in each of the four remaining endemic countries and emphasis given to implementing the agreed outbreak response guidelines adopted at the WHA in 2006 (Fifty-ninth World Health Assembly, 2006; GPEI, 2015i). Despite progress made in several areas, the target of cessation by 2012 was not achieved and a **Global Polio Emergency Action Plan 2012-2013** was developed to support Afghanistan, Nigeria and Pakistan in interrupting transmission. Partner agencies committed to additional surge support (WHO, 2012).

In 2012, India had been polio-free for one year and the number of polio cases globally fell from the previous year by 66 percent, to a total of 223. Angola, DRC and Sudan, which had previously been re-infected, had no cases and Chad had not reported a case since June 2012. In Afghanistan about 15,000 children remained unreachable. In Nigeria, 2012 saw an increase in cases, reflecting a volatile situation in the North. The one case in Niger was linked to a strain of the virus originating in Nigeria; and WPV, imported from Pakistan, was detected in sewage samples in two areas of greater Cairo, although no case was reported. Two further sources of concern were the the occurrence of attacks in Pakistan in December 2012 which resulted in the murder of nine vaccinators and the killing of ten polio workers in Kano, Nigeria in February 2013. These attacks compromised vaccine coverage in subsequent SIAs; a multi-pronged approach was used to respond, including lowering the profile of campaigns, provincial/state security coordination mechanisms and district-specific risk assessments. Broad-based initiatives sought stronger societal support, particularly among Muslim populations and Islamic leaders and institutions.

In all three endemic countries, National Emergency Action Plans (NEAPs) had been established and there was a massive surge of technical assistance to the highest risk areas. Viruses from endemic areas, particularly Nigeria, regularly re-infected polio-free areas and, for the first time, in 2012 more countries suffered a polio outbreak due to a cVDPV than due to WPV. More affordable IPV options had been developed and the SAGE recommended withdrawal of OPV type 2 as soon as possible from routine vaccination programmes in all countries (GPEI, 2013d).

The UN Secretary General hosted a high-level meeting on the polio eradication emergency at the 67th session of the UN General Assembly in September 2012, in which the ending of polio was declared to be a top priority (GPEI, 2013a).

Finally, one of the most important events of the 2010-2012 period was the GPEI's establishment of the IMB, which held its inaugural meeting on 21–22 December 2010 ("WHO Urges Polio-Endemic Countries to Completely Halt the Transmission of the Wild Polio Virus by 2012," 2011). The IMB met quarterly to monitor the implementation and impact of the Strategic Plan 2010–2012, offering frank insights into the financial, political, social and cultural hurdles to be overcome and calling for additional resources to ensure the full implementation of the plan. Additionally, the Board did not hesitate to intensify pressure on the international community, viewing the completion of polio eradication as a global health emergency from its earliest meetings, and stressing the need for accountability at all programme levels (GPEI Independent Monitoring Board, 2011). The 2012 WHA resolution on polio noted the IMB statement that *"polio simply will not be eradicated unless it receives a higher priority – in many of the polio-affected countries, and across the world"* and the IMB's recommendation in its April 2011 report that the WHA *"considers a resolution to declare the persistence of polio a global health emergency"* (Sixty-fifth World Health Assembly, 2012). The resolution further acknowledged the SAGE statement that the unacceptable risk of failure to finish global polio eradication constituted a programmatic emergency of global proportions for public health.

The Secretariat report to the 2013 WHA began with a commentary on the **Global Emergency Action Plan 2012-2013** (WHO, 2013c). A Polio Emergency Steering Committee had been set up by the five core agencies working on this plan, reporting to their Agency Heads that in turn constitute the membership of the Polio Oversight Board (POB)(GPEI, n.d.-f). The report noted that emergency operations centres (EOCs) and/or procedures had been activated and WHO and UNICEF had recruited thousands of additional workers to support government efforts or serve as community mobilizers in affected and high-risk areas of Afghanistan, Nigeria and Pakistan. Strong action had been taken by the Head of State or Government in each of the three endemic countries; new performance monitoring systems were put in place to track SIAs and guide rapid corrective action where needed;

and progress was achieved in vaccine coverage in all three countries. Beyond political and operational challenges, the report also noted key financial barriers, with reference in particular to the financing shortages of the PEESP 2013-2018. The overall budget for the Plan was US$ 5,525 million – peaking in 2013 at US$ 1,054 million, then declining each year to US$ 760 million in 2018. In February 2013 the funding gap was US$ 660 million.

2.6 Progress in the Polio Endgame from 2013-2018

The most recent GPEI strategy, the **Polio Eradication and Endgame Strategic Plan 2013-2018** (PEESP) was set out as the basis for the final phase of activities for polio eradication (GPEI, 2013d). By 2012, the global incidence of polio had been reduced by more than 99 percent to 223 WPV and 71 cVDPV cases and Afghanistan, Nigeria and Pakistan were the three remaining endemic countries. Despite the notable success of the GPEI, difficulties in access to children and renewed outbreaks meant the job was still incomplete. Responding to the IMB's recommendations, the 2012 WHA declared that the completion of polio eradication was a ***programmatic emergency for global public health*** and that affected Member States should also declare polio transmission a ***national public health emergency***.

The PEESP emphasized the necessity of innovations tailored to national contexts, and the need to develop more effective tactics and tools that would reach the remaining missed children, including those living in extremely poor sanitary conditions. It was based on the recognition that, as had been the case in India, missed children come from populations underserved by health systems, such as nomads, slum dwellers, children of construction and brick kiln workers, or other mobile and migrant groups.

The PEESP was developed in consultation with a wide range of stakeholders including Gavi, The Vaccine Alliance (Gavi), donors, national and international Technical Advisory Groups and the IMB. New elements included strategic approaches to end all WPV and cVDPV-related disease; urgent emphasis on improving immunization systems in key geographies; introduction of new, affordable IPV options for managing long-term poliovirus risks; risk mitigation strategies; new threats such as insecurity in some endemic areas and contingency plans for any delay in interrupting transmission in such reservoirs; and a concrete timeline to complete the programme. It also broke new ground by outlining a **legacy planning process** to harness the GPEI lessons and infrastructure *"to deliver other critical health and development resources and, ultimately, complete the GPEI programme"*.

The GPEI status reports from 2012 onwards detailed progress in diverse areas including environmental surveillance, security, polio sanctuaries and trends in missed children and in the gender profiles of frontline health workers in countries such as Pakistan, Afghanistan and Nigeria (GPEI, 2012; WHO, Rotary International, US-CDC, & UNICEF, 2013a, 2013b, 2015). Some of the reports also pointed towards the endgame and identified strategies that could be useful in transitioning.

Environmental monitoring is a key tool for ensuring that live poliovirus is quickly detected, its source identified and new disease outbreaks prevented. Examples of effective environmental surveillance include a case where WPV type 1 (WPV1) was isolated from sewage samples collected at Viracopos International Airport in the State of São Paulo, Brazil in 2014 and closely matched a strain of type WPV1 that had recently been isolated from a case of polio in Equatorial Guinea (WHO, 2014a). More seriously, in 2013, WPV1 was isolated from sewage samples collected at ten different sites in central and southern Israel. There were no polio cases, but a sustained campaign was undertaken to raise immunization levels (WHO, 2013e).

Despite some success, the 2014 Secretariat report to the WHA noted that WPV cases increased in 2013 by 82 percent and occurred in eight countries as opposed to five the previous year (WHO, 2014e). Increases were observed in Pakistan, the Syrian Arabic Republic and Cameroon. Differing combinations of insecurity, attacks on health workers and bans on immunization by local authorities meant that access had deteriorated in FATA and KP in Pakistan as well as in Borno state, Nigeria. In addition to security-related barriers, poor implementation also affected areas in Nigeria and Pakistan and it was estimated that over half a million children remained inaccessible in polio-affected areas in the two countries and a similar number in the re-infected part of Somalia. The IHR Emergency Committee in 2014 also advised urgent regional actions be taken due to large-scale, cross-border population movements (WHO, 2014d, 2014f).

In an effort to mitigate the impact of cVDPV, preparations were made for the global withdrawal of OPV containing type 2 virus in 2016 (see Box 4) and a joint programme of work was initiated with Gavi to support the strengthening of routine immunization in the ten priority countries identified in the PEESP. The SAGE finalized its policy recommendations for the administration of IPV in routine immunization schedules and endorsed the strategy that was developed for the financing, supply and introduction of IPV globally. There would be funding of expedited processes through Gavi for the 73 countries eligible for its support, with volume purchasing and UNICEF-assisted procurement for other countries.

The Secretariat's report to the 2015 WHA detailed measures taken to overcome severe challenges encountered in the previous year (WHO, 2015e). A meeting of the IHR Emergency Committee in April 2014 advised that global eradication would fail if the spread of the virus seen in the first three months was left unchecked. On 5 May 2014 the DG declared the international spread of WPV a **public health emergency of international concern (PHEIC)** and issued or extended a number of temporary recommendations, which continue to be in effect as of November 2016.

The 2015 Secretariat report further developed plans for legacy planning against a background of the successful use of the polio eradication infrastructure in response to the Ebola outbreak in West Africa, especially in Nigeria. The WHO Regional Committees had concluded that *"legacy planning should benefit existing health priorities and be driven and led by countries, and that its success would require a formal process to be established in all countries where substantial assets for polio eradication were financed through external resources"*. The POB had approved a draft framework and transition guidelines were being prepared for legacy planning at country level. The plans were to ensure that essential polio eradications functions continue beyond the end of the GPEI.

After the DG's declaration of the spread of WPV as a PHEIC and with more than 85 percent of cases in one country (Pakistan), the polio resolution of the 2015 WHA urged Member States to implement the PEESP 2013-2018, as well as national emergency plans, and to take necessary measures to ensure the safety of health workers. Furthermore, financial resources would need to be made available and the full realization of potential legacy ensured. The resolution also insisted that annual reports should continue to be made up to the 72nd WHA in 2019 (WHO, 2015b).

Progress in 2015 saw the number of cases of WPV decrease to only approximately one fifth of the total in 2014. They were all WPV1 and had occurred in only two countries: Afghanistan with 20 cases (28 cases in 2014) and Pakistan with 54 cases (306 cases in 2014). In both countries, WPV interruption now depended especially on addressing issues of security and gaining the cooperation of local leaders. No case of polio had occurred in Nigeria since 24 July 2014 and therefore Nigeria was officially removed from the list of endemic countries on 25 September 2015(WHO, 2015g).

Following the detection of two cases of cVDPV1 in Ukraine in June and July 2015 and a delay of several weeks, the Ukraine Government eventually held a press briefing to announce the outbreak and the need for a full and comprehensive emergency response. This included establishment of a joint Ministry of Health-WHO-UNICEF national task force and initiation of an in-depth investigation by a national/international team of experts in the affected area to prepare the outbreak response plan, oversee implementation and conduct monitoring (GPEI, 2015k).

Box 4: The Big Switch

In April 2016, the GPEI and WHO undertook what has been identified as the world's largest ever global vaccine rollout (Nazer & Eltayeb, 2016). Labelled 'the switch' by GPEI and various media outlets, the plan entailed stopping the use of trivalent oral polio vaccine (tOPV) and introducing bivalent OPV (bOPV) as an alternative within a two week timeframe in the 155 countries then using OPVs for polio immunization (GPEI, 2016b; McNeil Jr., 2016). Two critical factors drove the decision to make this transition. First, the Global Commission for the Certification of Poliomyelitis Eradication (GCC) declared the eradication of WPV2 on 20 September 2015, the last detected case having occurred in 1999. This meant that the type 2 virus strain included in tOPV was no longer needed to protect against WPV2, while it remained a source of cVDPV and VAPP. Second, the GPEI recognized that due to the rare evolution of OPV to cause cVDPV, successful eradication would eventually require global transition from OPV to IPV. Switching from tOPV to bOPV was the first step in this transition.

On 20 October the SAGE reviewed the situation of type 2 vaccine-derived polioviruses and stated that the switch from trivalent oral polio vaccine to bivalent (types 1 and 3) OPV should take place between 17 April and 1 May 2016 in all countries still using tOPV. Regarding containment, in 2015 the GCC and the SAGE urged the acceleration of implementation of the WHO Global Action Plan to minimize poliovirus facility-associated risk after type-specific eradication of WPV, setting out specific measures to be completed by Member States with support from the Secretariat (WHO, 2015f).

In preparation for the switch from OPV, all countries had committed to introducing IPV into their routine immunization programmes. However, there were technical difficulties in scaling-up encountered by manufacturers, leading to reduction in supply. The SAGE advised the use of IPV in higher risk tier 1 and 2 countries before the switch. Catch-up vaccination should take place once sufficient supplies were available and a stockpile of monovalent OPV type 2 established and maintained to be able to respond should an outbreak occur.

Despite persistent challenges in global IPV stocks, the levels of engagement, political commitment, international cooperation and resources invested in making the 'switch' possible have been impressive.

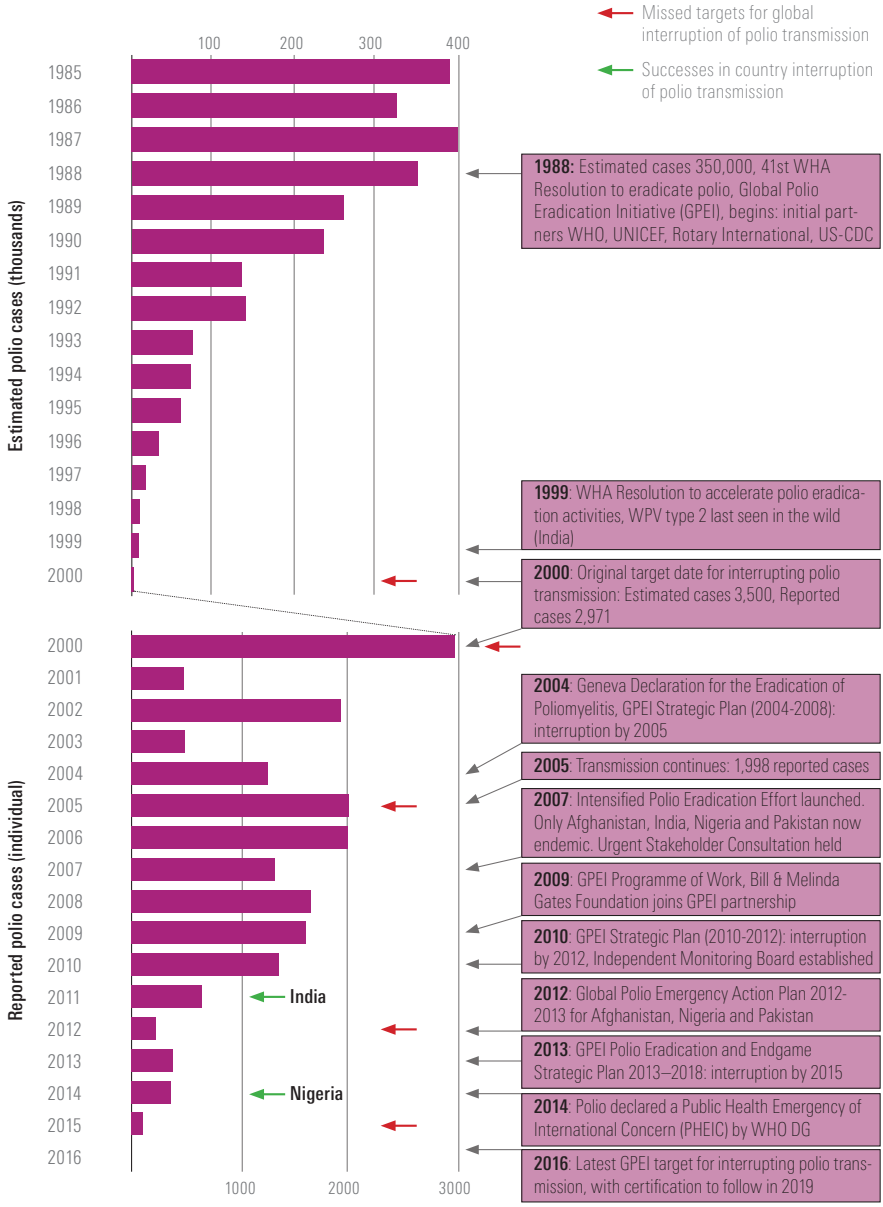
Legacy planning was accelerated in 2015, aiming to ensure that functions needed to maintain a polio-free world after eradication (e.g. immunization, surveillance, outbreak preparedness and response, and facility containment of polioviruses) will be mainstreamed in on-going national public health programmes; knowledge generated and lessons learnt from polio eradication activities will be shared with other health initiatives; and where feasible and appropriate, capabilities, assets and processes will be transferred to support other health priorities. According to the GPEI, this transition planning needs to occur primarily at national level, with polio-related assets also benefitting other development goals (GPEI, 2015g).

The December 2015 GPEI Newsletter noted several major milestones celebrated that year (GPEI, 2015d). Following shortly thereafter however, the Report of the Secretariat to the January 2016 EB stressed the concern expressed by the IHR Emergency Committee about the emergence of cVDPV type 1 and 2 strains in three WHO regions in 2015 (GPEI, 2015d; WHO, 2015d). This highlighted the importance of strengthening routine immunization systems. The IHR Emergency Committee recommended extending the temporary recommendations to countries affected by such outbreaks, while previous recommendations had been limited to countries affected by WPV.

The Secretariat reported to the 2016 WHA that strong progress was being made on each of the four objectives of the PEESP 2013–2018, but there had been delay in interrupting WPV transmission globally and consequently increased costs (WHO, 2016d). With on-going cross-border transmission, Afghanistan and Pakistan continued to be treated as one epidemiological block. A mid-term review of progress in implementing the PEESP had concluded that the key strategic elements to reach polio eradication were in place, but priorities in some programme areas needed to be refocused; in particular, filling gaps in surveillance, reaching missed children and enhancing outbreak preparedness and response in high-risk areas. A comprehensive plan was being developed to operationalize the review's recommendations.

It was noted in the Secretariat's report that, while all countries committed themselves to introduce at least one dose of IPV vaccine into their routine immunization programmes, there was also a reduction in IPV vaccine supply due to technical difficulties manufacturers had encountered in scaling up production. The SAGE had advised prioritization of the use of IPV vaccine. Manufacturers had announced further difficulties in February-March 2016 and the supply situation would remain fragile through 2017. SAGE also emphasised that a stockpile of monovalent OPV type 2 should be established and maintained in order to facilitate outbreak response, should it be needed. Meanwhile, global action on the containment of poliovirus type 2 was making progress.

Box 5: Timeline of the polio eradication initiative



3. THE ENDGAME: HOW AND WHEN WILL ERADICATION BE ACHIEVED?

The 13th Report of the IMB from August 2016 set out in stark terms the dangers that the world faced as the GPEI strove to interrupt polio transmission in the last endemic countries (GPEI Independent Monitoring Board, 2016). Despite further substantial improvements, the 'peak performance' that the IMB had called for in its 12th Report had still not been reached; the switch in type of OPV being used had heightened the risk of outbreaks of VDPVs, there was a world shortage of IPV and key reservoirs of WPV remained in Afghanistan and Pakistan. There continued to be significant weaknesses in both countries' polio programmes. The Report was written before the new WPV cases emerged in Borno, Nigeria in July-August 2016, but noted that there were half a million children being missed in that state due to insecurity.

The report recommended urgent action at all levels, from local to global. While many of the recommendations concerned intensification of technical approaches, the IMB also reiterated a call it had made in an earlier report for the establishment of a publicly prominent 'Red List' of vulnerable countries. In its report, the IMB argued the Red List, which had only briefly been operational, should be re-established, seeing this as a lever to engender greater political pressure and motivation to improve performance. The IMB's championship of the 'people factors' and the use of social data had been demonstrably effective, with results ranging from the valuing and training of vaccinators, to really understanding why parents were avoiding having their children immunized, to empowering women as health workers in their communities. However, polio programmes had paid a heavy price for not adequately responding to factors made apparent by social data in some key areas. Among the IMB's list of seventeen major concerns in its 13th report were several with a political focus, including inadequate levels of collaboration between the governments of Pakistan and Afghanistan; the low degree of political engagement in Northern Sindh, Pakistan; patchy performance and poor accountability of NGOs that deliver basic health services through contracts with the Afghanistan Government; waning commitment in Nigeria leading to a lack of full resilience against the re-emergence of polio; failure to take advantage of the benefits that could flow from maintaining a publicly prominent Red List; and a lack of planning for the continuation of polio vaccinations after eradication has been certified and the GPEI itself has been disbanded. The twelve recommendations that followed in the report included several aspects of political action at global and country levels.

This chapter begins with an overview of general endgame challenges and the wider determinants of polio eradication, before delving into more specific profiles of remaining endemic countries.

3.1 Endgame Challenges

Ultimately, the eradication of polio depends on the convergence of two streams of effort, one technical and the other addressing a host of other, complex determinants. The technical aspects include: ensuring the manufacture of sufficient quantities of safe, affordable vaccines; building the global supply chain that delivers them to every child in the world while avoiding stock-outs and interruptions in the cold-chain, securing the necessary finances; and organizing the vast cohorts of managers, health workers and laboratory staff that operate the entire enterprise. Yet, if the technical aspects alone were sufficient, polio eradication would likely have been completed more than a decade ago. The fact that it has not points to the need to address a range of determinants outside of the health sector. This comes as no surprise in light of the seminal work of Sir Michael Marmot and the Commission on the Social Determinants of Health, which has demonstrated that a wide array of economic, environmental, political, social and other factors play a decisive role in determining health outcomes (WHO Commission on Social Determinants of Health, 2008).

An editorial in 2013 in The Lancet observed that polio remained entrenched in Afghanistan, Nigeria, and Pakistan, where *"social, political, and logistical factors prevent effective vaccination campaigns and lead to export of virus to countries that have previously been free of the disease"* ("2018 must be the final target for polio eradication," 2013). The eradication target of 2018 was not the first deadline for polio eradication, but as cases become fewer, *"the problems become knottier, and hindrances to final eradication become ever more dependent on localised factors and characteristics of the virus's remaining toeholds. As the saying goes, the devil is in the detail"*. The PEESP 2013 – 2018 was deemed *"an excellent example of how data, local knowledge, and experience can be synthesised to provide clear goals and realistic targets. 2018 seems soon, but for some children it will not be soon enough. And for the vaccination workers who have lost their lives, eradication of polio within 5 years would be a tribute to their efforts"*.

The wider determinants

Conflict: A 2015 paper discussed possible social and political factors that have impacted polio eradication and might continue to do so during the endgame (Ganapathiraju, Morssink, & Plumb, 2015). It focused particularly on problems that have affected polio eradication programmes in the two countries which were then classified as endemic, namely Afghanistan and Pakistan, as well

as Nigeria. The authors noted that polio transmission was concentrated in conflict-affected regions in Afghanistan. Similarly, Pakistan saw SIAs being interrupted because of violence and as a result of targeted attacks on vaccinators, resulting in an increase in WPV cases and exportation into Afghanistan and Syria.

Social factors: As posited by Sir Michael Marmot (2013), a *"human rights approach to health supports giving priority to improving health and reducing inequalities,"* which requires *"absolute action on the social factors in polio eradication as a major policy challenge"*. As far as polio eradication is concerned, the principal social factor has been *"inadequate flexibility in accessing children safely"*. While awareness of polio eradication may be widespread, many of those in affected communities have not perceived vaccination as a high priority. In addition, community leaders were *"not educated nor mobilized to get more invested in polio vaccination"* (Toole, Simmonds, Coghlan, & Mojadidi, 2009).

Social dynamics influenced by religion have also impacted polio eradication in some areas. In northern Nigeria, for example, which is predominantly Muslim, the Supreme Council of Islamic Affairs has control over the population *"for whom religion is a way of life."* In some communities, it was thought that polio was caused by *"evil spirits who drink blood of victims"* resulting in paralysis or death. Other cultural factors include beliefs in native medicine and choice of 'traditional doctors' as opposed to vaccination (Osazuwa-Peters, 2011).

Efforts made to improve social mobilization must involve women as an important part of polio eradication programmes. This has included using women literacy students, a programme that was first launched by UNICEF in Jalalabad, Afghanistan, as well as female vaccinators and supervisors.

Political factors of concern are the deadly attacks in fragile areas, which have affected Pakistan, Afghanistan and Nigeria. It should be noted, however, that the central causes of the failure of polio eradication are country-specific. In the case of Afghanistan, according to Toole et al (2009), while President Karzai wanted to bring an end to the Afghan war via a political settlement with the Taliban, they would not negotiate while US and foreign troops were in the country. Therefore political endorsement of polio eradication programmes may have been counter-productive. At the same time, the Taliban could have been unlikely to carry out attacks on polio vaccinators, as they wished to regain control of national politics in Afghanistan, to rebuild trust among the population and to allow locals to engage in social campaigns, including the GPEI.

An analysis by Abimbola and colleagues in 2013 observed that the situation remained fragile as terrorist forces entering Afghanistan could interfere with polio eradication efforts as part of a strategy for countering the Western front in Afghanistan (Abimbola, Malik, & Mansoor, 2013). Although polio vaccinations were carried out for 15 years without interference in Pakistan, more recently there have been attacks on vaccinators in FATA and other areas, and the situation was exacerbated by the use of polio campaigns as a cover for espionage by the CIA, as well as by the conduct of drone strikes. In addition, the attention given to the attacks by international media *"led terrorist groups to believe that they can achieve some of their aims by interfering with polio eradication*".

In the case of northern Nigeria, vaccination campaigns were stopped in Kano, Zamfara and Kaduna states by political and religious leaders, who believed that the vaccine was contaminated with anti-fertility agents. This belief had its roots in the 1980s when the then President Babangida *"embraced a policy to control the population by limiting the number of children a woman should have"* and this was then linked to the polio vaccination campaign (Ganapathiraju, Morssink, & Plumb, 2015, 468). In addition, the power shifted to the south, increasing tensions within the country and the lack of trust of the federal government by northern Nigerians and linked to the prominence of Boko Haram.

Ganapathiraju et al. noted that the current political climate of violence in these countries was not as conducive to global coordination as it had been during the smallpox eradication programme, which had been supported by both the USA and Russia, and with national campaigns continuing even during long-standing wars. At the global level a political dimension was added with the spread of polio being considered a global public health emergency in 2013 and formally declared a PHEIC in 2014. The authors saw this as *"using a 'top-down' authority approach"*, whilst the major problems were local and it was at this level that political streams needed to engage in the process. The authors posed the provocative question of whether the 'visible cluster' of policy actors such as WHO, UNICEF, US-CDC, Rotary International and BMGF should also include "*the Taliban, Boko Haram and the continued support of the Imams of Nigeria"* (Ganapathiraju, Morssink, & Plumb, 2015, 469).

The authors observed that WHO and Western health agencies prefer to use persuasion rather than force. However, they pointed out that mandatory vaccination plans were used with the assistance of national and local support, including the police and paramilitary units. According to the authors, such use of force should be short-term and must clearly benefit the public at large. In three countries discussed, however, they concluded, *"it is the political violence around other policy issues with the resulting breakdown of law enforcement that will make mandating the polio endgame a no-win strategy"* (Ganapathiraju, Morssink, & Plumb, 2015, 470). The alternative to using force is respect for individual choice and securing individual and communal buy-in. The authors argued that this

entails the public realization of polio as a threat; then education for behavioural change can be used *"as a crucial mediator in political, economic and social determinants of health"*. In the case of polio eradication, achieving an increase in vaccination rates requires that parents realize the severity of the disease. However, the authors pointed out that in the case of the populations that were being targeted, individual freedom of choice may not fit in with their cultural framework.

In concluding, the authors considered that campaigns should be negotiated away from the political strife in each of the countries. They emphasized that *"polio vaccination is part of a larger set of children's health issues that should be addressed worldwide"* in the context of the Convention of the Rights of the Child, and highlighting the importance of child health in the context of legacy planning (Ganapathiraju, Morssink, & Plumb, 2015).

A paper by Callaway (2013) discussed polio eradication in Nigeria and noted that the country did not have a working public health-care system and lacked commitment from some of the local government officials. Security was an issue and there have been deaths of several polio workers in Kano. The main focus of the paper was on factors that led to acceptance or refusal of polio vaccination. Nomads were seen as a polio reservoir, spreading the disease during their migrations, which led to a census of Fulani nomads and other hard-to-reach populations. The Fulani nomads had little access to education or health care from the government. However, the nomads rarely refused polio vaccinations and were eager to have other health and veterinary services.

Callaway's paper cited the view of David Heymann, Chair of the Advisory Board for Public Health England and the former head of polio eradication efforts at WHO, that the lack of a working public health-care system was a problem and other countries with migrant populations had been successful (e.g. India offered polio vaccinations at train stations). However, parents in the north of Nigeria had refused vaccination for their children because of widespread distrust of the government. Religious opposition to vaccination among settled populations had now been supplanted by refusals driven by disenchantment. According to Heymann, *"people want things other than polio vaccination. They can't understand why people are coming once a month to give them vaccination when what they want are treatments for their children with fever or diarrhoea"*(Callaway, 2013).

Vaccination refusals have been a major challenge to polio eradication efforts and have led to a risk of coercion on some occasions. A paper by Rentmeester et al. (2014) considered vaccine coercion in Moradabad, India. Coercive strategies had been adopted to implement the uptake of OPV during pulse rounds of the programme. A December 2013 issue of *The Indian Express* was cited, in which escalation in the use of vaccine campaigns was referred to as a political and social 'bargaining chip'

among factions in the region (Rentmeester et al., 2014). This came at an important time as India was preparing for certification of polio eradication, with the District Administration threatening to invoke the stringent National Security Act to counter threats of boycott of the NID round of vaccination. Coercion was also referred to in the context of historical malaria, smallpox and family planning campaigns and vaccinating health care workers against influenza. The paper noted the lack of a GPEI system-wide plan to compensate sufferers of harms -for example, those affected by VAPP caused by the OPV.

Political support and encouragement remains an important factor in sustaining the effort during the polio endgame. A GPEI news story reported that at the Commonwealth Heads of Government Meeting in November 2015, the UN Secretary-General, the Prime Ministers of Australia, Malta and Pakistan and Ministers of Canada and the UK, as well as the newly elected Commonwealth Secretary-General and President of Rotary International, joined a high-level event to *"commend the historic progress made against polio and commit to ending the disease once and for all"*(GPEI, 2015c). Pakistan's Prime Minister emphasized that the government would not rest until polio is eradicated from the country, while Australia's Prime Minister stressed his country's commitment to the campaign. Ban Ki-moon thanked the Commonwealth leaders for their support, calling on them to *"make the final push and wipe out polio from this earth"*. The Nigerian Minister of Foreign Affairs referred to WHO's decision to delist Nigeria as an endemic country, saying that his country would remain vigilant to ensure that polio is completely eradicated from Nigeria. Several countries outlined their ongoing financial commitment, including Canada and the UK.

The economic case for eradication

An economic analysis of eradication versus control for polio in 2007 showed decisive long-term benefits for eradication which more than offset the high costs involved in achieving it (Thompson & Tebbens, 2007). As noted in the Report by the Secretariat to the Sixty-fourth WHA (2011), the results of a new study on the economics of the GPEI were released at the launch of the Strategic Plan 2010–2012 (Tebbens et al., 2010). The study indicated that the incremental net benefits of completing poliomyelitis eradication, aggregated over the period 1988–2035, would be at least US$ 42 billion. However, shortfalls in GPEI financing continued to result in a scaling back of SIAs and surveillance activities in some areas; delays in implementing outbreak response activities in others; and reductions in the long-term technical assistance provided by the Secretariat to some Member States. In March 2011, 38 percent of the 2011-2012 budget of US$ 1,860 million remained unfunded. As highlighted by the GPEI (2010b), this study underscored the benefits of completing the job of polio eradication, both in terms of humanitarian and economic benefits. Global commitment to the eradication of polio was made with an expectation of large potential benefits. At the

end-stages, a disproportionate focus on the high costs for polio eradication might adversely influence this global commitment.

With target dates being missed and given that implementing the PEESP 2013-2018 would cost US$ 5.5 billion and require additional resources from countries, it was important to examine the economic case for continuing to invest in polio eradication. A summary of a report by McKinsey and Company prepared for BMGF in consultation with the GPEI partners was presented in 2012, providing cogent arguments supporting the goal (GPEI, n.d.-a).

There were only three endemic countries in 2012. Since 1988, US$ 9 billion had been invested. The net benefits already generated were US$ 27 billion, out of an estimated US$ 40-50 billion total. According to the study, there were three core economic arguments for continuing to invest in polio. First, **eradication is more cost-effective than alternatives**. At 2012 levels of routine immunization, the report predicted there would be a rapid resurgence of polio to 200,000 cases a year within five years, over time amounting to millions of children paralyzed for life. Over 20 years, cumulative costs would exceed US$ 35 billion, while the net benefit of eradication would be US$ 19-25 billion. Past analysis had suggested that incidence would stabilize at about 50,000 cases of paralysis each year within three to five years and operational costs would rapidly surpass annual eradication costs. Compared with this, eradication would generate net benefits of US$ 6-10 billion over 20 years. Second, **the GPEI's commitment to strengthening routine immunization and other health services brings added value**. The GPEI's programmes have reached an unparalleled numbers of the world's poorest and most disadvantaged children. From 1988 to 2010 GPEI workers administered up to 1.3 billion doses of Vitamin A during polio campaigns, averting at least 1.1 million deaths and creating an economic benefit of at least US$17 billion. The PEESP 2013-2018 sets explicit targets to increase immunization coverage in the 10 most affected countries (e.g. averting 30-35,000 deaths in Nigeria in 2014-2018, resulting in an economic benefit of US$ 4 billion.). Third, **the GPEI is carefully managing its resources and making efforts to be more efficient**. The Initiative is taking an active approach to resource management and ensuring that efficiency is maximized and donor investments well-spent.

The study concluded that polio eradication was within sight but not assured and achieving it would require investing significant resources. Nevertheless, eradication *"remains unequivocally more cost effective than the alternatives presented"* (GPEI, n.d.-a, 8). Failure to act would also allow polio to continue claiming victims and threatening to spread to other polio-free countries. In contrast, eradicating polio would create a polio-free world and significant momentum for other public health initiatives.

More recently, a systematic review in 2015 (Sicuri, Evans, & Tediosi) addressed questions related to the elimination and eradication of infectious diseases, focusing on 'why, how and for whom?' It concluded that although elimination and eradication are, for some diseases, good investments compared with control, countries' incentives to eliminate do not always align with the global good. Furthermore, efficient elimination strategies may not prioritize the poorest populations. For any infectious disease, policy-makers need to consider realigning contrasting incentives between individual countries and the global community, and ensure that the process towards elimination/eradication considers equity.

3.2 Remaining Endemic Countries

A 2012 CSIS report detailed many shared challenges to polio eradication in Afghanistan and Pakistan (Lamb, Chang, Chavez, Hameed, & Mixon, 2012). These included the long, generally uncontrolled shared border; weak governments and poor health infrastructures; cross-border activity including the movements of refugees fleeing conflict; security environments putting polio workers' lives at risk and making areas inaccessible; compromised health infrastructure and widespread exposure to unhygienic conditions due to natural disasters and persistent conflict; the related movements of internally displaced persons hampered efforts to quarantine the virus; and the refusal rates in some Muslim communities with some religious and political leaders denouncing vaccination efforts based on arguments of a Western conspiracy or that the vaccines cause infertility. The report summarised many local strategies being used to overcome the challenges, but concluded that *"neither country has fully put in place the mechanisms needed to ensure that stakeholders, especially at the local level, are resourced, committed and accountable"* (Lamb et al, 2012, 10).

The 12th IMB report (2015) also provided recommendations for Pakistan and Afghanistan. These included that the governments of the two countries should establish a joint executive and planning board to instigate cross-border polio prevention and control. According to the IMB, top priority should be given to stopping transmission in Peshawar and the surrounding regions, including addressing the mismatch between the 'epidemiological' geography of polio and the 'planning and coordination' geography, possibly by reconfiguring the regional EOC arrangements. The report recommended that the US-CDC conduct a special review of the pattern and genetic features of the positive environmental samples in different geographical areas of Pakistan. Finally, it recommended that the most senior members of the GPEI work with programme leaders in Pakistan and Afghanistan to plan a precisely targeted series of campaigns of IPV alongside OPV.

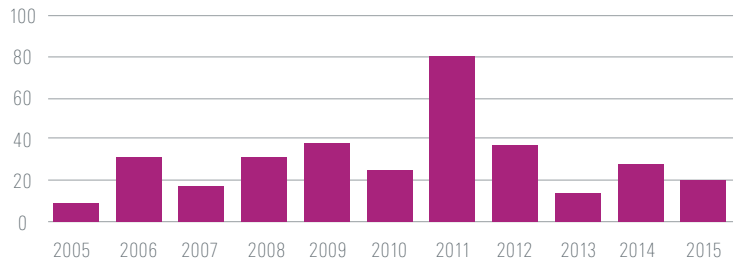
Afghanistan

Afghanistan's National Emergency Action Plan (NEAP) for July 2013 - June 2014 (2013) revised from an initial plan developed in 2012, identified six key intervention areas including low performing districts (in the Southern and Eastern regions) (WHO, n.d.). The plan had a special focus on missed children (most of whom were in areas where the teams had access) and enhancing communication directed to increase community demand and ownership (especially at household level and by religious leaders and elders). The NEAP also noted that efforts were needed to train staff at all levels and introduce an accountability framework, including key monitoring indicators. A new polio campaign, *"Ending Polio is MY RESPONSIBILTY"*, was launched, routine EPI emphasized and WHO and UNICEF recruited additional staff.

A subsequent NEAP was published in 2015, focusing much more on the key areas, taking a more strategic approach than hitherto and emphasizing the importance of cross-border collaboration (Islamic Republic of Afghanistan, 2015). It aimed to interrupt the circulation of indigenous WPV by the end of June 2016, as well as respond to cross-border importation, while maintaining the polio-free status of non-infected areas. The 2015 NEAP received full commitment from the Afghanistan President and other leading politicians and officials.

There were 20 WPV cases in Afghanistan in 2015 (GPEI, 2015b). This was lower than the 28 cases reported for 2014, but not evidence of a simple downward trend, as annual case numbers have fluctuated over the last decade (Box 6).(GPEI, 2011, 2015m) Twelve WPV cases were reported in 2016, the last with onset on 12 October (GPEI, 2016c).

Box 6: Wild polio cases, Afghanistan 2005-2015 [1]



1 Data compiled from GPEI Wild poliovirus lists (2011-2016). Accessed 6 February 2017. http://polioeradication.org/polio-today/polio-now/wild-poliovirus-list/

An overview by Chukwuma et al. (2015) of polio eradication in Afghanistan in 2014-2015 highlighted strategies needed to interrupt transmission in the coming year, especially relating to cross-border transmission and weaknesses in Afghanistan's routine immunization system and coverage in Supplementary Immunization Activities (SIAs) in the regions suffering insecurity and conflict. The Secretariat's report to the EB in January 2016 referred to the children missed not only because of inaccessibility, but also because of the *"operational deficits in accessible areas"*. It also shed light on the solution that broke the temporary suspension of vaccination activities by local leaders in some of the areas in the Southern Region, *"by highlighting the importance of maintaining the neutrality of public health efforts"*, with high-profile endorsement by political, international and military figures possibly being unnecessary and counter-productive in non-secure areas (Mohamed et al., 2009). The report highlighted that *"although a national emergency action plan has been established, its implementation is incomplete"* and there should be stronger coordination through a better-functioning EOC to reach persistently-missed children.

The IMB concluded in its 12th Report (2015) that Afghanistan's programme was not working properly. The country had recorded more WPV cases in 2015 than at the same time the previous year, and there was a risk that it would be *"the weak link in the drive for interruption of transmission in 2016"* (29). The report highlighted the issues of missed children, insecurity and the porous border, weak social mobilization and vaccination team performance. It also acknowledged the fragmentation of anti-government elements that made it more difficult to negotiate access and the fact that relationships between the Afghanistan Government and the WHO and UNICEF country offices were not well aligned and were *"frankly ineffective"*.

In late 2015, security in parts of Afghanistan seriously deteriorated with the Taliban taking control of key areas in Helmand Province and major problems occurring in Nangahar province involving both Taliban and Daesh/ISIS. Newspaper reports highlighted the challenges, including in recruiting female health workers (Nikzad, 2015), and in working in Nangahar (Derville, 2015; Mukhopadhyay, 2015) which borders Pakistan and saw outbreaks of WPV in 2014 and 2015 (Polio Eradication Initiative Afghanistan, 2015).

Pakistan

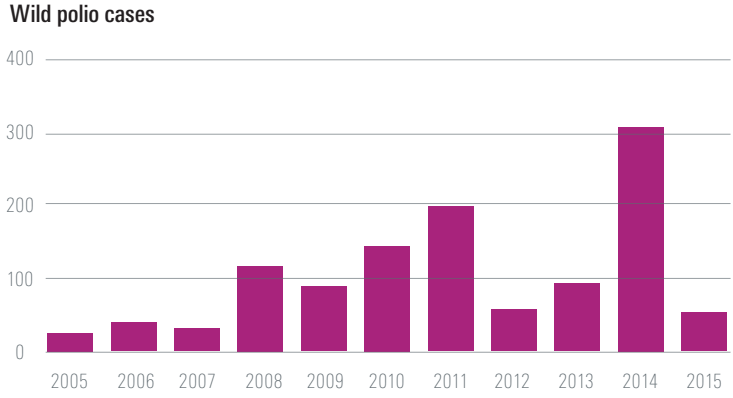
A 2016 editorial (T. Khan, Abbasi, Khan, & Nadhman) highlighted some of the adverse events that Pakistan experienced in the past decade, including earthquakes in 2005 and 2015; the fight against terrorism and prevailing militancy; floods in 2010 and 2013; and panic created by the violent targeting of polio workers. As of January 2016, Pakistan was lagging well behind the target set in the PEESP 2013-2018, despite the polio case count being the lowest ever. The authors concluded that the

country should strengthen its disaster management system, with vaccination as a main pillar, while giving focus to improvement of the health system.

Problems recognised in Pakistan's polio eradication effort included the persistence of significant pockets of missed children, inefficient payment mechanisms, poor selection, supervision and support of frontline workers and attacks on polio workers and their escorts (Naeem et al., 2011). Pakistan had 86 percent of the global case count in 2014, reporting 306 WPV cases, with more than 84 percent being in children under 2 years of age and only 22 percent having received 1-3 OPV doses. Intense transmission and extensive population movements due to conflicts meant that the virus spread to other areas. However, military operations in North Waziristan led to a population exodus which allowed 260,000 children to be reached on their outward journey, through Permanent Transit Points. Military operations also allowed children in previously inaccessible areas of the Khyber agency to be reached after many years. Nevertheless, WPV continued to circulate within known endemic reservoirs and spread to other areas.

There were 54 WPV cases in Pakistan in 2015 (GPEI, 2016c) – considerably lower than the 306 reported for 2014, but annual case numbers have fluctuated substantially over the last decade (Box 7) (GPEI, 2011, 2015m). Twenty WPV cases were reported in 2016, up to the week of 31 January 2017, the last having onset on 22 December 2016 (GPEI, 2017).

Box 7: Wild polio cases, Pakistan 2005-2015[2]



2 Data compiled from GPEI Wild poliovirus lists (2011-2016). Accessed 6 February 2017. http://polioeradication.org/polio-today/polio-now/wild-poliovirus-list/

Building on the previous NEAP (Islamic Republic of Pakistan, 2014), Pakistan's 2015-16 NEAP (Islamic Republic of Pakistan, 2015) included ensuring adequate protection for all polio activities; increased efforts to vaccinate inaccessible, underserved or mobile populations and ensuring effective communication, situational awareness, coordination and integration at all levels.

Nishtar (2009) discussed the uneven progress in Pakistan since 2000 and the geopolitical and socioeconomic challenges that could jeopardize programmes aimed at eradicating polio. The failure to achieve polio eradication demonstrated not only the weakness of the health services – Nishtar referred to a triad of insufficient public-sector funding, a poorly regulated private sector and lack of transparency in governance acting together to compromise the quality and equity of public services – but also the importance of determinants outside the health sector in influencing health status, such as access to war and conflict zones; parental refusal; and cross-border problems with Afghanistan. Furthermore, Nishtar argued that broad-based reform was needed to address systemic weaknesses, but that this was not a priority at the time, as the country struggled on many diplomatic and security fronts.

A US-CDC article (Farag et al., 2015) covering the period 2014-2015, recognized the improvement in the quality and scope of polio eradication activities after the establishment of a National EOC in Pakistan, with activities being carried out in line with the NEAP including a rigorous action plan for the polio low-transmission season (January - April). A report by the International Crisis Group (2015) pointed out that the key test would be in May 2016, when, at the end of the low-transmission season, the temperature would begin to rise and with it the risk of the virus spreading. In their view, countrywide success in protecting children from polio would depend on the government's willingness to partner with civil society and local and international NGOs, which are less restricted in their ability to access vulnerable populations. This strong emphasis on the role that NGOs can play is not seen frequently in relevant literature, in which there are indeed caveats about the role of international NGOs.

In a study by Tiefengraber (2013) highlighting the positive and negative roles that both state and non-state actors can play, the difficulties in polio eradication in Pakistan were explained as rooted in four main areas: the weak state and health system, particularly in tribal areas; ongoing conflict, including drone strikes; prejudices against the polio vaccine; and backlash against the instrumentalisation of health campaigns by security and intelligence agencies. The Taliban had not only prohibited vaccination campaigns for children, schooling for girls and women working outside the home, but they have viewed foreign NGOs – particularly those working in the social or health sector – as suspect, pointing to them as having a reputation of working for foreign donors' rather than

national interests (Roul, 2014). Tiefengraber noted, responding to the targeting of health workers and the stance of the Taliban, that the GPEI met with Islamic scholars in Cairo in 2013 and agreement was reached that the vaccine was *"safe, effective and in accordance with Islamic law, and that immunization is a religious and social responsibility for everyone. Indeed, preventing immunization is forbidden by Islam"* (Organisation of Islamic Cooperation, 2013). Tiefengraber also cited the May 2011 fake hepatitis vaccination programme in Abbottabad, to obtain DNA from Osama bin Laden's family, as an example of humanitarian relief or health efforts being used for military intelligence such that the neutrality of humanitarian assistance is undermined.

T.M. Khan's book (2008) on the tribal areas of Pakistan gave a general introduction to their administration and peoples, and discussed the history of these areas and of the border with Afghanistan. The border was set as a political expediency in the 19th century and divided tribes and trade routes. As stressed in conversation between Khan and Haslegrave (2013), the border has always been highly porous and has remained a major factor compounding the difficulty of expanding immunization coverage and stopping the cross-border transmission of polio. Concerns expressed by local officials in some of the frontline areas in Pakistan included security concerns, undocumented cross-border movement on a large scale, the recruitment and protection of polio workers including Lady Health Workers, failures in the cold chain, misinformation and antagonism by the Taliban and some clerics, and weaknesses in the health infrastructure and local governance.

Nigeria

Violence from terror groups has been a threat to people in northern Nigeria for many years. The armed group Boko Haram gained international attention with atrocities such as the murders of three Korean doctors and thirteen helpers in February 2013 (Associated Press Potiskum), as well as the abduction of 200 school girls in April 2014. The violence affected development, health care delivery and also the fight against polio, with polio vaccination teams in northern Nigeria requiring protection against attacks (KfW Development Bank, 2014). UNICEF and WHO, with 5 million Euro support from the German development bank, Kreditanstalt für Wiederaufbau (KfW), set up security programmes to be able to vaccinate as many under-5 children as possible. These programmes aimed to integrate political and religious leaders from the regions to obtain greater acceptance of the vaccinations among the population. In addition, the local medical teams comprising a vaccinator, a traditional opinion leader and a health worker would offer basic health care as well as administering vaccinations during house-to-house visits. The strategy also included a greater number of short-term vaccination campaigns, with helpers spending only one to two days in a region secured by local authorities or security experts.

Despite these difficulties, transmission of polio in Nigeria was apparently interrupted with a final case occurring on 24 July 2014. At the 25th session of the African Union in June 2015, Heads of State and Government noted that the entire African continent had not reported a single WPV case for over ten months. They reaffirmed their commitment to global polio eradication and that they should *"help deliver a polio-free Africa as a historic legacy to children of all future generations"*, highlighting *"the wider legacy of the polio infrastructure and resources and the critical role it can play in strengthening routine immunization, supporting broader disease surveillance and emergency health response efforts"* and noted the use of polio infrastructure in tackling the Ebola virus as a living example of this legacy (African Union, 2015). In September 2015 WHO formally delisted Nigeria as a polio endemic country.

Many celebrated the progress made, which was attributed to successful leadership and oversight, systematic engagement of the community, and the enforcement of an accountability framework by government at all levels. Polio eradication efforts in Nigeria overcame several challenges, including fierce resistance to the vaccine among religious groups and threats from armed militias like Boko Haram, as well as spoiled shipments of vaccines due to a lack of reliable refrigeration in remote rural areas. There was improved organization to reach the missed children, and coordinated efforts of donors, African governments, health workers, partners, religious and community leaders (BBC, 2015; Desmarais, 2016; Muhammad, 2015; Santamaria, 2015).

On the first anniversary of the last reported polio case in Nigeria, Bristol (2015) warned that the success should be viewed with a note of caution. Continued political attention and sufficient resources would be needed to achieve official polio-free certification by WHO after three full years with no cases. Nigeria had nearly been successful before, when there were only 21 cases of WPV in 2010. By 2012, however, the number of cases had gone up to 122. As Bristol pointed out, Nigeria was working toward the political will and polio programme quality needed to become polio free officially, but this meant that improvements would be necessary and Nigeria was not yet safe. It *"must build further resilience and…move its programme from good to great"*.

In its 12th Report (2015), the IMB gave a balanced assessment of the situation in Nigeria after it had been removed from the list of polio endemic countries. The change in Nigeria's polio status should be a source of pride, but not a cause for celebration, as areas of inadequate immunity remained in parts of Nigeria, as well as in other African countries. The risk of re-introduction therefore remained substantial. The IMB cautioned that in several areas disease surveillance was below par and further strengthening resilience would be the key to sustaining the gains made.

These expressions of caution proved to be appropriate. Two new cases of WPV were detected in Borno, Nigeria in July 2016 and officially reported to WHO in August. They had a close genetic match with a case in Borno in 2011. An outbreak response plan was rapidly instituted, focusing on both Nigeria and the Lake Chad sub-region more broadly (WHO, 2016a). A third case was reported on 6 August 2016. All three were caused by WPV1 and the virus was linked to cases from Borno in 2011, indicating this strain has been circulating undetected since that time. This indicated that Nigeria had always been affected by endemic circulation of WPV1 and it was therefore re-added to the list of endemic countries, alongside Pakistan and Afghanistan (WHO, 2016g).

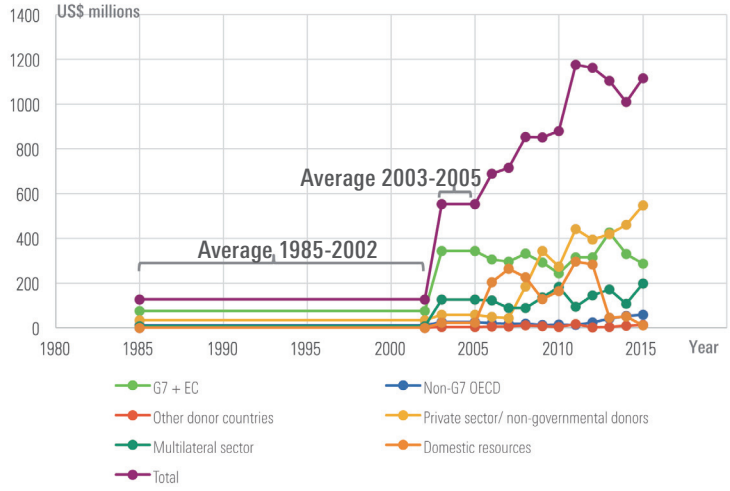
3.3 Other countries

In addition to Afghanistan, Pakistan and Nigeria, there are a number of other countries in which cases of cVDPV1 have occurred, including the Lao PDR, Madagascar, and Ukraine. The IMB 12th Report (2015) referred to the infection in Ukraine, noting that it had warned about the poor state of children's preventive health services there, which had been followed up with high level representations and warnings to the government from other sources, *"but to no avail"*. The IMB considered the response in Ukraine to be *"nothing short of shameful"* and no response had been made *"within the timescale that international standards require"*. The IMB also commented on the situation in Syria and other countries in the Middle East, noting that many of those that were now affected had good levels of polio vaccine coverage before the conflicts in the region, but the populations were now vulnerable, as seen in the outbreak of 38 polio cases across Syria and Iraq in 2013. The situation had remained fragile in the region and political leadership and commitment to polio had not been strong. The large population movements across the region and into Europe continued to represent a potential risk of resurgence of polio, particularly among Syrian refugees.

4. FINANCING THE GPEI

The GPEI's ability to attain and sustain financing over the course of almost three decades has been simultaneously one of its greatest achievements and is now one of its most urgent challenges. This chapter provides an overview of the historical trajectory of GPEI financing. It then highlights the financial needs projected to successfully finish the endgame, providing critical insight, in particular, into European perspectives and contributions.

Box 8: Contributions to the Global Polio Eradication Initiative, 1985-2015[3]



A detailed listing of contributions and pledges to the GPEI has been produced (GPEI, 2016a). Funding for the period from 1985 to 2015 is summarised in Box 8. Total contributions rose to a peak of US$ 1.179 billion in 2011 and subsequently fell back to US$ 1.010 billion by 2014 before rising again to US$ 1.114 billion in 2015. The G7 and EC has been the largest donor group, raising its combined contributions to an average of c. US$ 340 million per year between 2003 and 2005 (a high proportion of this coming from the G7) and a total of US$ 3.141 billion in the decade 2006-2015. The most prominent increase in this decade was from the category of private sector and non-governmental donors – mainly due to contributions totalling US$ 2.457 million from the BMGF.

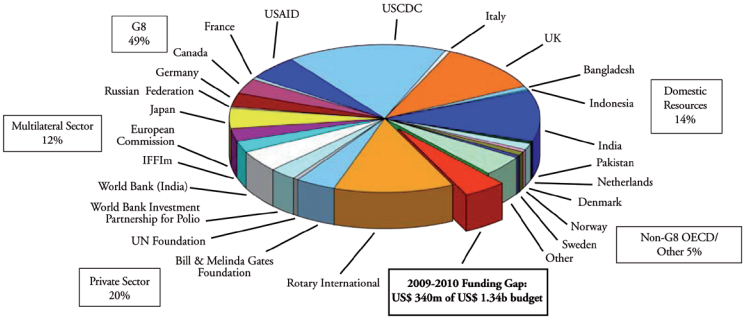
3 Graph data from: GPEI (2016a). Contributions and Pledges to the Global Polio Eradication Initiative, 1985-2019. http://polioeradication.org/wp-content/uploads/2016/07/Historical-Contributions_31March2016_FINAL.pdf

4.1 A chronological overview

By the time the 2009 Programme of Work was underway, the GPEI had raised over US$ 7 billion since 1988, with 47 public and private sector donors contributing over US$ 1 million each and 29 donors contributing US$5 million or more (Box 9). Funding of US$ 1.47 billion was also raised for the *intensified polio eradication effort* in 2007-2008.

Box 9: Global Polio Eradication Initiative financing [4]

1988 to 2010: US$ 7.13 billion
1988 to 2008: US$ 6.13 billion expenditure; US$ 1 billion contributions



The 24 funders shown in the Chart have each contributed more than US$ 25 million to global polio eradication.

The work of the GPEI is guided by multi-year strategic plans with associated budgets. For the US$ 2.14 billion budget described in the **Programme of Work 2009 and Financial Resource Requirements 2009-2013**, the primary cost driver was the continuation of the *intensified polio eradication effort*, which accounted for 58 percent of the five-year budget. Planned expenditures were prioritised, in case income targets were not met. The Programme of Work also addressed the budget implications of persistent poliovirus transmission and the financial implications for a 12-month delay in any of the remaining areas of indigenous transmission. These were estimated at up to US$ 225 million for India, US$ 143 million for Nigeria and US$ 92 million each for Pakistan or Afghanistan.

4 Graph data from: GPEI (2009). Budgetary implications of the GPEI Strategic Plan and Financial resources requirements, 2009 – 2013, as of January 2009. Geneva: WHO. http://polioeradication.org/wp-content/uploads/2016/07/FRR2009-2013_January2009_ENG_USformat.pdf

The move to the GPEI PEESP 2013-2018 presented a new financial challenge, with the 6-year budget requirement increasing to a record US$ 5.5 billion. This figure excluded approximately US$ 1.23 billion Government of India funding and any other national or in-kind contributions. The GPEI's partners developed a strategy for long-term, predictable funding for the period. The Plan was endorsed by more than 400 scientists and global health experts on 11 April 2013 in a Scientific Declaration on Polio Eradication ("Scientific Declaration on Polio Eradication," 2013). At the Global Vaccine Summit in Abu Dhabi shortly afterwards, global leaders and individual philanthropists pledged three-quarters – or US$4.04 billion – of the PEESP's projected US$ 5.5 billion costs over six years (WHO, 2013b). Adding to the effort of BMGF, commitments were also made by several other foundations and philanthropic bodies (Bill and Melinda Gates Foundation, 2013).

The financial requirements of the PEESP are reviewed and updated quarterly and the proportion of requirements under key budget categories adjusted as progress against key milestones is evaluated. The picture at the end of December 2014, which was based on the projection that WPV transmission would be interrupted worldwide in the following year, indicated that US$ 2.22 billion had been committed for the six year Plan and a further US$ 2.85 committed or projected to be contributed, leaving a funding gap of US$ 0.45 billion still to be met at the time (WHO & UNICEF, 2015).

The initial PEESP 2013-2018 budget of US$ 5.5 billion was subsequently increased by a further US$ 1.5 billion when the target date for interrupting all WPV transmission was moved from 2015 to 2016. The European region will play a critical role in helping to meet the GPEI funding requirements for this period, both through the contributions of individual countries and through the EC.

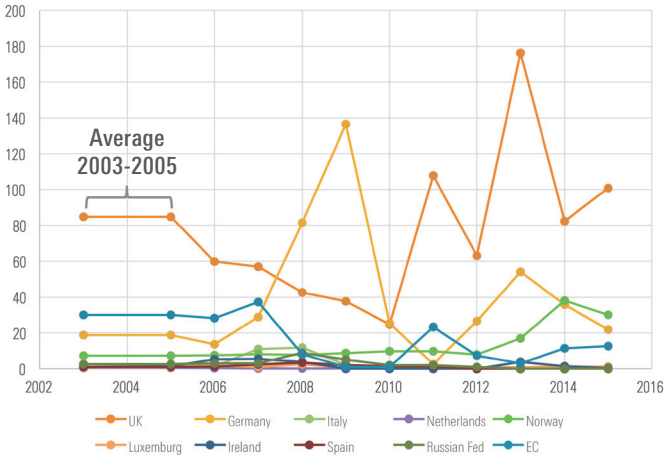
Europe's financial contribution to the GPEI since the programme was established amounted to US$ 2.8 billion (20.6% of the total) in the period 1988-2015, while the region currently accounts for about a quarter of world GDP and more than half of world Official Development Assistance (ODA).

The recent history of European contributions is presented in Box 10, which illustrates the contributions from the EC and the nine largest donors among European countries (UK, Germany, Norway, Italy, Russian Federation, Ireland, Luxemburg, Spain and Netherlands) since 2003. In the ten year period 2006-2015, these leading European sources contributed US$ 1.52 billion. Seventeen other European countries contributed a total of US$ 0.05 billion in this period, giving a total of US$ 1.57 billion, which corresponded to 16.4% of the total contributed from all global sources. For comparison, the USA's total contribution for 2006-2015 was US$ 1.523 billion.

Within the period of the current GPEI PEESP, full data on annual pledges and contributions is available for 2013-2015. In this period, the EC and nine donors illustrated in Box 9 contributed a total of US$ 592.04 million. Eight other European countries contributed a total of US$ 3.74 million in this period, giving a total of US$ 595.78 million. This corresponded to about 18.4% of the total of US$ 3.23 billion contributed from all global sources.

In June 2015, the European Parliament announced the passage of a written declaration in support of the global effort to eradicate polio (European Parliament, 2015; Rotary International, 2015). This was followed by the passing of three new amendments by the European Parliament designed to increase funding in the EU for polio elimination (Vaccine News Daily, 2015).

Box 10: GPEI funding by EC and main European country donors, 2003-2015[5]



5 Graph data from: GPEI (2016a). Contributions and Pledges to the Global Polio Eradication Initiative, 1985-2019. http://polioeradication.org/wp-content/uploads/2016/07/Historical-Contributions_31March2016_FINAL.pdf

4.2 Future funding for the Endgame

Given the current worldwide financial crisis and the forecast for possible economic downturn, a number of governments are carefully examining their ODA contributions to see where possible cuts might be made. This is even more the case in Europe, where countries have been faced with large influxes of migrants and refugees. While a clear case can be made for the funding of the endgame and legacy, the reticence of some governments that have traditionally been strong supporters of GPEI must be examined and considered objectively. The picture is not homogenous, but based on diverse situations and policies of the countries concerned. Nevertheless, insofar as Europe will need to be an important player in funding the endgame and legacy, it deserves special consideration.

On the positive side there has been commitment by the UK, the third largest donor, that they *"remain firmly committed to polio eradication"* (Hurd, 2015); while on the negative side there have been signs of a change in perspective of the traditionally supportive Nordic countries. There also appears to be a move in some quarters away from funding intergovernmental agencies, including some of those within the UN system. The literature relating to these trends is discussed below.

United Kingdom Department for International Development (DFID)

In its 2013 Business Case, DFID justified why it should continue to intervene by supporting polio eradication in the 2013-14 to 2018-19 period with a package totalling GB£ 300 million (c. US$ 430 million at the then prevailing exchange rate) (DFID, 2013). It pointed to the leadership role that the UK could play within the G8 and GPEI, noting that it was *"instrumental in maintaining commitments from other G8 members (particularly Germany)"*. Its matching challenge fund mechanism in 2011 and 2012 also provided incentives for other donors, both public and private, to contribute to the global eradication effort.

The DFID Annual Review Summary Sheet in September 2015 noted that the UK was committed to providing support for global polio eradication over the six years of the Strategic Plan (DFID, 2015). The document recognized that the endgame had been delayed by one year and that further funding to support this should be considered.

Germany

After peaking at US$ 136.51 million in 2009, Germany's contributions to the GPEI fell precipitously in 2010 and then rose again to a few tens of million per year from 2012. In parallel with the support to the GPEI, Germany has made substantial direct inputs to polio eradication at the country level through the channelling of funds from German Federal Ministry of Economic Cooperation and

Development (BMZ) through KfW (originally founded in 1948 as the Kreditanstalt für Wiederaufbau and now serving to promote sustainable economic, social and ecological developments in Germany and worldwide). For example, 96.5 million Euro was contributed for polio eradication in Nigeria from 2004 to 2015, with some funds earmarked for measures to make the health workers more secure in high-risk areas such as those affected by Boko Haram. KfW has also supported polio eradication in Afghanistan and Pakistan (KfW Development Bank, 2014; 2015).

Political support for polio eradication has come from Germany's Chancellor Angela Merkel (who received the Rotary International Polio Champions Award in 2008) and the German Cabinet, as well as other politicians (GPEI, 2013c; Schütt, 2008). Writing in June 2016, German MP Stefan Rebmann noted that the German government had been a strong and reliable partner to the GPEI since the beginning of the initiative, which it had supported with more than US$ 500 million, and was the first donor to pledge an additional 100 million Euro to finance the GPEI Endgame Strategy (Rebmann, 2016). He also called for the EU to lead the way by encouraging its members to increase their support to polio eradication and create a blueprint for taking on tomorrow's threats to global public health.

Norway and other Nordic countries

The total Norwegian contribution to the GPEI was US$ 179 million in the period 1985-2015, with US$ 145 million of this being contributed from 2006-2015. The donations, which had been running at US$ 7-10 million per year from 2003-2012, increased sharply to US$ 17 million in 2013 and US$ 38.1 million in 2014, sliding back to US$ 30.15 million in 2015, evidently as a result of a currency depreciation. At the Global Vaccine Summit in Abu Dhabi in 2013, the Norwegian government announced that it intended to contribute NOK 240 million (then US$40 million) for the GPEI in 2014, a sharp increase from planned contributions of US$8 million (NOK 50 million) in 2013, and to sustain this level through to 2019 ("Norway: Donor Profile," 2016). However, the Norwegian kroner declined in value against the dollar by about one third between 2013 and the end of 2015. Norway's pledge to the GPEI is currently shown as US$ 31.67 million per year for each of the years in the period 2016-2019 (GPEI, 2016a).

Norway has also made direct contributions to polio eradication in a number of countries, including support for programmes in Afghanistan, Nigeria and Pakistan ("Australia, Norway increase aid for polio eradication ", 2014) and, together with BMGF and UK, support for introduction of IPV in 72 Gavi-supported countries including Afghanistan and Pakistan (GPEI, 2015a, 2015e).

Against a background of overall strength in ODA and advocacy for 'social sectors' or 'soft policies', it is striking that other members of the core Nordic group have not matched Norway's support for polio eradication. GPEI contributions from Denmark ceased in 2006, those from Finland in 2010 and those from Sweden were interrupted in 2006 and it then made only one further donation (US$ 0.7 million in 2013).

A report by Hansen, Gjefsen and Lie (2015) examined the unique role of the Nordic countries in their efforts in peace, sustainable development and poverty alleviation, which had been characterized by high levels of development aid with poverty alleviation as the overall objective. Their politicians have also invested time and resources in peace negotiations, SDGs and gender equality. This was referred to by the authors as "the Nordic exceptionalism" – by which they mean idealism. However, the authors also noted that shifts seemed to be under way which prompted the question whether 'Nordic exceptionalism' was coming to an end.

Particular concern was raised when, in October 2015, major amendments to Norway's national budget were presented by the Norwegian Government in their plan for financing the expected additional costs related to the massive increase in refugees coming to Norway, which had already begun to impact on the 2015 ODA budget (Anders, 2015; Norad, 2016; OECD, 2016). In the proposed revised aid budget, while an additional NOK 1.2 billion for ODA was added to the Government's original budget proposals, going beyond the 1 percent of GNI mark, it also increased the amount of ODA dedicated to covering Norway's reception of refugees from NOK 1.9 billion to NOK 7.3 billion, representing an increase from 5 percent to 21 percent of the aid budget going to refugee costs inside Norway. This would impact most on civil society organizations, as well as cutting the allocation for the UN system.

5. THE INTERDEPENDENCE OF LEGACY AND ENDGAME

Much attention is currently paid to the ways that the legacy of polio eradication can be embedded in health systems, so that the eradication of polio will be of broader benefit to national health systems and will contribute to achieving the universal health coverage (UHC) target within the 2030 SDGs (United Nations General Assembly, 2015). At the same time, a part of the potential polio legacy is its impact on the global health system and structures, including specific lessons for future disease eradication campaigns, and for the architecture and governance of global health institutions. This chapter includes literature that deals with both the national and global aspects.

Bristol (2014) pointed outthat while the GPEI continued an acute focus on completing global polio eradication, it was also anticipating its own post-eradication demise. There was an identified risk of losing systems and innovations which the Initiative developed and funded – many of which could be used to support other health programmes. The GPEI was therefore beginning to catalogue and assess the assets it had created and seek ways to transfer them to government health systems and other health initiatives as part of polio legacy planning. With the end of polio in sight, the main goals for transition planning for the GPEI are to protect a polio-free world (through resilience) and to ensure that the investments that have been made to eradicate polio contribute to future health goals after the completion of polio eradication (through transitioning) (GPEI, 2015j).

The processes which are needed to achieve eradication are not independent from those required in the transitioning of assets to sustain and benefit from the legacy of polio eradication. The two strands of action are intertwined and must be co-managed to achieve their goals jointly. Shifting the emphasis towards legacy as the final cases of polio dwindle poses the risk that attention and willingness to contribute resources to sustaining eradication may be weakened.

In a statement (Frieden, 2015), the Chair of the POB referred to legacy transition planning. The legacy process involves continuing basic polio functions by incorporating them into health programmes, documenting and sharing the lessons learned and knowledge generated with other health initiatives and transitioning capabilities and processes to support other health priorities and promote sustainability.

5.1 The Legacy of Polio: Transition and Resilience

The literature and policy documents reviewed which discuss the legacy or transition planning of the GPEI are generally concerned with one or more of the four following factors: 1) the prominent role of polio-funded programmes in the delivery of routine immunization and other essential health services in the most underserved communities, 2) the breadth and depth of polio programme staffing and the need to transition and account for the immense human resources of the GPEI following eradication, 3) the vast network of infrastructure and laboratories maintained through polio eradication efforts and the need to continue surveillance and ensure containment, and 4) capturing and integrating the processes, approaches, and lessons learned through this unprecedented global health initiative into national and global health systems.

Processes and Lessons Learned

An article by key personnel in GPEI major partners highlighted five general categories of lessons: mobilizing political and social support; strategic planning and policy development; partnership management and donor coordination; programme operations and tactics; oversight and independent monitoring (Cochi, Freeman, Guirguis, Jafari, & Aylward, 2014). The authors highlighted what they considered to be the ten leading lessons learned from the polio eradication Initiative (Box 11) and provided an explanation, discussion and examples of each. They cautioned that the assets from smallpox disappeared very quickly after its eradication. Additionally, there is an interrelationship between the GPEI lessons learned and the transition of its assets, both tangible, (e.g. the global surveillance/laboratory network), and more intangible (e.g. accumulated knowledge, best practices, functions, processes, systems, activities, and methods of work). The paper concluded that lessons learned from the GPEI, as well as its infrastructure and unique functions could contribute to strengthening overall immunization programmes, especially routine immunization systems in low-income countries.

An article in October 2015 by Peter Crowley, head of the UNICEF polio team, attributed the success of the polio eradication initiative to date to a wealth of data, innovation, community engagement, research and community links (Crowley, 2015). He considered that the success hinged on the 'game changers' and that the efforts of the GPEI partners could only go so far without the commitment and leadership of a country's own government, citing India and Nigeria as examples, while noting that there had also been a shift in Pakistan. Recent setbacks such as the outbreaks of cVDPV in the Ukraine and Lao PDR must be prevented by intensifying efforts, and by strengthening and maintaining optimal levels of immunity around the world. When eradication is achieved, it will leave behind not only a world that is free of this paralyzing disease, but also a potential legacy of systems, learning and innovations that can support the continuing quest for a healthy future for all children, everywhere.

Box 11: The ten most important lessons learned in the GPEI (Cochi et al., 2014)

1. Communications and community engagement: mobilizing social and community support for vaccination
2. Communications and community engagement: using targeted disease initiatives as a springboard for broader health communication
3. The value of an advanced, state-of-the art global, regional, and national laboratory network
4. Real-time disease surveillance and response capacity, data analysis, and immunization programme monitoring
5. Addressing strategy implementation in conflict-affected areas and the risks of international spread to previously polio-free countries
6. Essential need for a programme of research and innovation
7. Partnership coordination, advocacy, and resource mobilization
8. Strategic planning and policy development
9. Oversight and independent monitoring and evaluation
10. Monitoring of programme accountability and performance

5.2 Transition Planning

At the December 2014 meeting of the POB, the then Chair of the PPG, Ambassador Lange, stated that the GPEI should focus on explaining the broader (i.e. non-polio) benefits of polio eradication in external communications, particularly in messaging to donors, pointing out that many of these messages had been articulated in the legacy planning process (Polio Oversight Board, 2014). He stressed the importance of focusing on legacy planning going forward and of reinforcing the relationship between GPEI and Gavi, *"noting that as GPEI succeeds, it is possible that donors will decrease their contributions and partners will decrease their staff with potentially serious implications for non-polio programmes (e.g. measles)"*. In addition, in response to a request for guidance, the POB agreed that legacy planning should primarily be a country-led process, but that global level support and guidance was also important and could play a major role in ensuring the full benefit of legacy planning. India's largely successful transitioning of polio assets and functions is frequently referred to an example of success for this approach (See Box 12).

Box 12: Polio Eradication in India: Success, Transition and Legacy

India's success in interrupting WPV transmission was achieved with *"solid financial, political, and logistical commitments from the national government, unwavering support from the international community, and innovative, relentlessly methodical record keeping and oversight"*. The success in polio eradication was a major accomplishment which, according to government officials, built confidence and pride in government health programmes and local communities. India has provided an early example of a country transitioning from the eradication endgame to the incorporation of the polio assets in the national health services and structures.

Research by Bristol (2014) focused on India's actions to date in legacy planning and observed that the legacy had begun before India was declared polio free, with WHO moving polio staff to parts of the country that needed most help to improve routine immunization systems. Some states, moreover, agreed to pay the salaries for polio volunteers who could contribute to other health improvements, with WHO providing training, supervision and oversight. WHO was also transferring staff, previously paid by GPEI, to their regular budget. This transition was set out in WHO's Country Cooperation Strategy with India, which emphasized broadening the scope of disease-specific programmes in the country including those related to polio, AIDS, and tuberculosis (WHO Country Office India, 2012). Moreover, beginning in 2005 staff in all 35 states and territories were provided with training to incorporate measles into the polio surveillance system and in 2013 India, with other countries in the region, pledged to eliminate measles by 2020; an effort that would involve improving routine immunization systems and disease surveillance. This led to a drop in India in measles cases from 56,188 in 2009 to 13,822 in 2013. Nevertheless, there was still a long way to go in improving childhood immunizations throughout India and the health system had continued to display a weak infrastructure, lack of accountability and glaring resource inequities, particularly in the poorer states.

A further challenge was that India's National Polio Surveillance Project was almost entirely supported by external funding and would require alternative sources as the GPEI shrinks.

During their deliberations on a legacy planning update in June 2015, the PPG noted the steps that had already been taken, before suggesting several ways in which donors could support transition planning; for example, advocacy with national/state governors and key stakeholders to prioritize transition planning; contributing to global and country-level discussions; and providing funding and/or in-kind support for a rigorous transition planning process (GPEI Polio Partners Group, 2015). The Legacy Management Group (LMG) set up by the POB reports to the Strategy Committee, also set up by the POB. There is also a PPG Legacy Working Group. The responsibilities of this Group, as described by Paul Rutter, are to represent, communicate and coordinate on legacy issues with interested PPG stakeholders; encourage PPG members to participate actively in polio legacy transition planning; provide a regular forum for stakeholders to share information and develop common

positions; and plan how stakeholders can advocate around legacy planning. It has up to seven members representing governments, donors and civil society groups with interests in both polio and non-polio health issues and it works alongside and in partnership with the PPG.

The 2013-2018 PEESP fully integrates legacy planning as one of the four main objectives (GPEI, 2013d). A growing consensus has emerged that the *"assets, lessons and resources of the polio Initiative should eventually be transitioned, primarily through national governments, to benefit other existing health priorities"* and national governments should be responsible for the future administration of the 'human resources infrastructure'(WHO, 2013d). Further consultations were also held involving Member States, major partners and stakeholders and detailed legacy planning missions were conducted in the DRC and Nepal (WHO, 2015c). It was recognized by the WHO Regional Committees that legacy planning should be used to benefit existing health priorities and be country-driven and country-led, and a formal process should be established in countries in which substantial assets for polio eradication were financed through external resources.

A Midterm Review (MTR) published in July 2015 examined the main objectives, outcome indicators and major activities of the GPEI PEESP (GPEI, 2015f). According to the review, two progress indicators (1: initiate a global legacy process; and 2: complete a broad consultation process) had been achieved and that only the third indicator (3: establish polio legacy plan) remained incomplete, having achieved 80 percent of the goal, with some countries having *"delayed in polio legacy planning due to eradication status and delays in undertaking the process"*. Objective 4 of the PEESP was largely on track and aimed *"to ensure that investments made to eradicate polio contribute to future health goals, through systematic documentation and transition of the GPEI's knowledge, lessons learned and assets"*. This would be achieved by mainstreaming essential polio functions; sharing knowledge and lessons learned; and transitioning assets (people, physical assets, supporting tools/systems and enabling factors) to other health priorities. The report pointed to the role of the LMG in guiding the planning process at the global level and in reaching out to a wide range of stakeholders, as well as its engagement with the SAGE and IMB. Meanwhile country-level discussions were underway for India and had also recently started in Nigeria. It was consistently emphasized that legacy planning should not distract from eradication activities, with certain risks being identified with the third indicator related to the status of polio eradication in some countries and the possibility that others that had already interrupted transmission were slow in beginning legacy planning. The MTR also noted the lack of understanding of the legacy planning process among GPEI partner organizations, donor partners and at regional and country level, given it is a relatively new activity of the GPEI; and also that indicators for monitoring progress of country-level implementation were not included in the monitoring framework of the PEESP. The importance of engaging donors' interest in the

process was also indicated in the report. The MTR report considered that the *"urgency of beginning the legacy planning process cannot be overstated"* now that eradication was imminent and the reality that polio funding was limited was setting in. It made recommendations to increase the visibility and urgency of legacy planning work and to increase sustained surveillance capacity and quality.

The target date set for development of a comprehensive legacy plan was the end of 2015 (GPEI, 2013d). The Secretariat reported to the 2016 WHA that acceleration of polio legacy planning had continued in 2015, but that it needed to occur primarily at country levels and was still under way (WHO, 2016d). Guidelines for preparing country plans for transition of the assets and legacy of polio had been issued, with five guiding principles (GPEI, 2015g):

- Polio transition planning will benefit all countries and the global community, not only countries where polio resources are currently concentrated.
- Enabling long-term transitions to full country ownership of basic public health functions, wherever possible, is a priority.
- Under the leadership of the national government (and their subnational counterparts, where applicable), a broad range of stakeholders should be involved in the polio legacy planning process at the country level, including donors and civil society.
- Beginning the process of polio transition planning early represents the GPEI's desire to plan carefully and responsibly for the future.
- Legacy planning should not distract from the current focus on interruption of poliovirus transmission and other objectives of the 2013-2018 Strategic Plan.

The PEESP gave guidance on a wide range of topics and for countries at different stages of progress. Steps that should be taken were detailed, including discontinuation of polio programme functions and transitioning of assets. While the guidelines included some references to development in addition to health, they focused on ensuring that programme activities predominantly benefited the health sector.

Polio Programming, Routine Immunization and Other Health Services

While it is evident that legacy planning benefits a wide range of health priorities, such as the emergency response to the Ebola outbreak, the potential detrimental impact on routine immunization of ending of polio programmes and financing cannot be ignored. The legacy planning process must therefore *"find synergies with routine immunization and reinforce collaboration between the groups working on routine immunization and legacy planning"*. Pay disparity between polio and other health workers means there is not always a clear path for transitioning human resources from

polio eradication effort to other responsibilities. Countries with dysfunctional health systems, such as Somalia, are of particular concern as the reduced capacity of an already weak infrastructure would not be able to support other health priorities.

A study of the ten priority countries in Objective 2 of the PEESP, corroborated by self-reported data from Nepal, revealed that *"polio-funded staff spend a significant amount of time on other health priorities such as routine immunization and measles and rubella"* (GPEI, 2015f).

The above-mentioned 2015 MTR concluded that in some cases *"external technical assistance may be required to support the legacy planning process as will financial support to ensure that adequate time and resources are dedicated to the process of developing and executing legacy plans"* (GPEI, 2015f). Where possible, legacy planning should complement plans to strengthen routine immunization and the switch from tOPV to bOPV to avoid the burden of countries needing to develop another plan related to the polio endgame. The MTR report further noted that the transition process for both of these activities was complex, requiring extensive engagement with a variety of stakeholders.

The GPEI Workforce

The January 2013 EB requested that the Secretariat conduct an independent study of the financial risks associated with the human resources component of the GPEI, so they could be managed in the context of completion of the polio programme in 2018. In May 2013, the EB's Programme, Budget and Administration Committee requested that, in future, human resources reports should include an update on the situation. The report of the study on GPEI human resources was annexed to the Secretariat's report on WHO human resources for the January 2014 EB (WHO, 2014b).

The Secretariat reported to the January 2014 EB that the independent study had been conducted on the 22,000 people who were deployed by the GPEI, including the more than 7,000 contracted by WHO (WHO, 2013d). This study, which was designed to determine the financial implications of eventual closure of the polio programme, also consulted senior representatives of donor agencies, other health initiatives and some national governments to obtain their perspectives on long-term options for the polio-funded workforce. These stakeholders most frequently cited the surveillance (86 percent), laboratory (50 percent) and social mobilization (46 percent) functions performed by this workforce as of potential value for transition to other health initiatives. Two thirds of respondents stated that the future administration of this human resources infrastructure should be the responsibility of national governments.

The situation at the end of 2015 was summed up by Paul Rutter (2015) in his presentation to the PPG. He showed the magnitude of the numbers of GPEI-funded positions in some countries, with 11,186 in Nigeria, 9,761 in India, 3,198 in Afghanistan and 2,598 in Pakistan. The number of polio-funded positions in in South Sudan, Somalia, DRC, Chad, Ethiopia, Angola and Bangladesh range from 121 to 390, while other countries have fewer than 70. There were at total 146 laboratories in 92 countries. The strategy for 2016-19 would be published in 2016 and there would be a legacy session at the Ministerial Conference on Immunization in Africa ("Ministerial Conference on Immunization in Africa," 2016). Appropriately, the panel discussion on polio at this Ministerial Conference was entitled *"we are not quite out of the woods yet"* and Nigeria's Health Minister reported that the President had asked the governors sign a fresh commitment to polio eradication, saying *"the job is not over"*(Routine Immunization, 2016).

A new stage in the transitioning and legacy of polio eradication was initiated in 2016 with the creation of a Polio Transition IMB to be chaired by Sir Liam Donaldson (GPEI, n.d.-g). Established at the request of the POB, it will independently monitor and guide the process of transition planning, assessing the quality, sufficiency and impact of work being undertaken to achieve transition planning aims stated in the PEESP 2013-18.

5.3 Ensuring Resilience

Infrastructure, Surveillance and Containment

Another lesson in mainstreaming essential polio functions is the potential for surveillance systems to significantly decline after a region has been declared or certified polio-free. Examples include the Americas where polio surveillance indicators declined after the region was certified polio-free in 1994, as well as surveillance indicators in several countries in the European and Western Pacific countries which do not meet international surveillance standards (Aylward et al., 2000). Once polio is eradicated, it will be critical to integrate a surveillance system into a strong national disease surveillance system, including the use of environmental surveillance, to maintain a polio-free world.

With the interruption of transmission of WPV an imminent prospect, attention has been given to the question of containment to ensure that live virus does not get accidentally released and cause a new outbreak. The WHO guidelines for containment of poliovirus following type-specific polio eradication were published in 2015, in advance of the planned removal of the type 2 strain from OPV in April 2016 (Previsani, Tangermann, Tallis, & Jafari, 2015) (See Box 2: The Big Switch, in Chapter 2 of this review). The publication noted the links between minimizing the number of essential

facilities worldwide and reducing the risk; facilitating national and international oversight; and strengthening the likelihood that global containment standards can be met and successfully maintained. It was estimated that 500 facilities worldwide were holding type 2 polioviruses and that diagnostic laboratories would continue to be critical for surveillance for years to come. The need for continuation of polio vaccine production, surveillance and research well after certification takes place was also highlighted. It will be important to consider how this aspect of the endgame will contribute to the legacy going forward.

Bristol (2014) considered funding from some major donors beyond polio eradication as well as urging the US government, as a major contributor to polio eradication and global health issues, to support legacy planning. The transition occurring in funding means that some of the GPEI's projects and resources might face an uncertain future. For example, although it also responds to other diseases, the 145-facility Global Polio Laboratory Network could begin to falter without the support of the GPEI. There is a need to ensure continued resources for critical assets to guard against polio re-emergence and to provide for continuation and expansion of other health activities which are now supported by polio eradication resources. Bristol cautioned that while donors were previously focused on eradication, *"several are beginning to think how they might use their money later"*, with the GPEI's budget expected to diminish after 2018 (now 2019). She made a number of recommendations for the continued support of the US Government.

Other papers relevant to legacy planning include the report of a high-level PPG meeting on polio legacy planning in June 2014 (Freeman, 2014), a draft of the GPEI Endgame Strategic Plan 2013-2018 as of 14 April 2013 (GPEI, 2013b), a list of frequently asked questions on the legacy transition planning (GPEI, 2015j) and a presentation from WHO AFRO at the MTR Technical Advisory Group (TAG) meeting in June 2015 ("Polio Legacy Planning discussion on behalf of Dr Salla Mbaye, AFRO at MR TAG meeting," 2015).

A blog by a Senior World Bank Specialist on the Africa Region and others (Odutolu, Dimka, & Alade, 2016) highlighted the lessons that can be learned from Nigeria for the West Africa region to be better prepared to handle future disease outbreaks. Nigeria was able to contain Ebola as it was caught early and some components of the response were adapted from polio eradication efforts in the country, as well as from infrastructure and capacity built in response to an Avian Flu outbreak in 2006. The blog responded to the questions *"How did a previously weak system suddenly gain the momentum to operate efficiently and yield favourable outcomes? Are there lessons we can learn related to the effectiveness of future disease surveillance and emergency response efforts?"* It noted an alignment of several factors called the seven 'Ps'; namely politics of purpose, providing

the right platform, aligning people with processes, proactive public engagement, prolific partnerships, pioneering alternative pathways and priming the system.

The authors considered that, for Nigeria, investments in the EOC present a great opportunity. Extending its legacy could include the creation of decentralized EOCs in each state, to incorporate the health, animal and environmental sectors in a bid to achieve the "One Health" goal. Furthermore, the lessons learned about health systems, public institutions and their capacity to deliver must be well-documented and brought to bear in future planning.

5.4 Eradication efforts for other diseases

In terms of both a public health outcome and a global public good, the eradication of polio itself will leave a lasting mark on the world. This section contextualizes the legacy of eradication more broadly, both in terms of historical efforts to eradicate diseases prior to polio, and in terms of eradication projects yet to come.

The initiation of the GPEI in 1988 was preceded most notably by the successful effort to eradicate smallpox (WHO, 2010) concluded in 1980, while the current initiative to eradicate Guinea worm (The Carter Center, 2017) that has been running in parallel with the GPEI also appears to be drawing to a successful close. However, prior to smallpox there had been several failed attempts to eradicate other diseases. Available literature discusses campaigns against a number of diseases during the 20th century, including **hookworm, yellow fever, dengue, yaws** and **malaria** as well as **smallpox** and **Guinea worm**. Here, a snapshot of literature on different eradication efforts undertaken prior to the polio is provided, with a particular focus on the extent to which lessons and legacies were, or are now being captured.

Historical eradication efforts

Early eradication campaigns –the first being for hookworm (Dowdle & Hopkins, 1997; Humphreys, 2009), soon followed by yellow fever (Fenner, Hall, & Dowdle, 1997)– were initiated with support from John D. Rockefeller, and what would later become the Rockefeller Founation (The Rockefeller Foundation, n.d.).

Recognition that the viral disease **yellow fever** was being transmitted by Aedes aegypti mosquitos paved the way for early successes in eradication programmes in Cuba (1904) and subsequently Panama. The Rockefeller Foundation's International Health Board undertook a number of successful

yellow fever eradication campaigns after the First World War in Central and South America, but the resurgence of outbreaks in South America and the recognition of a jungle reservoir of the disease in mosquitos dwelling in the forest canopy indicated that eradication would not be achievable with the tools then available. Nevertheless, successes, along with advances made against malaria and other infectious diseases, led to over-confidence and resulted in a 30 year period of complacency and apathy during which resources were re-directed to other competing public health priorities. Vector-borne infectious disease control infrastructure deteriorated in most countries of the world (Gubler, 2011; Spellberg & Taylor-Blake, 2013). A safe and effective yellow fever vaccine emerged in the 1980s and has been the standard approach to controlling the diseases since then (Frierson, 2010). Debate about control versus eradication of yellow fever has resurfaced from time to time (Moreau, Girault, Drame, & Perraut, 1999). Since the launch of the Yellow Fever Initiative in 2006, significant progress in combatting the disease has been made in West Africa (WHO, 2016h).

Malaria was an early target of the Rockefeller disease eradication programmes, first in the USA (1915) and then in other countries (US Centers for Disease Control and Prevention, 2016). While an antimalarial drug, quinine, had long been available, the eradication strategy again depended heavily on the use of vector control measures against the Anopheles mosquitos that carry the parasite. The Rockefeller programme set the stage for the new insecticide dichlorodiphenyltrichloroethane (DDT) which became available in the early 1940s and was rapidly used with great effect to combat malaria, **typhus**, and the other insect-borne human diseases. In 1955 WHO initiated the Global Malaria Eradication Programme, which focused on indoor house spraying with residual insecticides, antimalarial drug treatment and surveillance. Successes included elimination in nations with temperate climates and seasonal malaria transmission. Some countries such as India and Sri Lanka had sharp reductions in the number of cases, followed by increases to substantial levels after efforts ceased, while other nations made negligible progress. In addition to concerns about the long-term toxicity and environmental impact of DDT, the emergence of resistance to the available drugs and insecticides, as well as wars and massive population movements, difficulties sustaining donor funding and lack of community participation made the long-term maintenance of the effort untenable. The goal of completing the eradication campaign was abandoned in 1969 (Carson, 1962; US Centers for Disease Control and Prevention, 2016). According to Stapleton (2004), the lessons of malaria control in the 20th century remain ambiguous. After a gap of three decades, a new global effort to control malaria was initiated in 1998 with the launch of the Roll Back Malaria Programme, which strongly emphasized the need for vastly strengthened local health systems. The UN General Assembly designated 2001-2010 as the Decade to Roll Back Malaria in Developing Countries, particularly in Africa (United Nations General Assembly, 2001). The WHA in 2013 expressed support for a proposal for the Secretariat to draft a global technical strategy for malaria for the post-2015

period (WHO, 2013f) and the strategy was presented to the WHO EB in January 2015 (WHO, 2014c), subsequently adopted by the 2015 WHA and published as the Global Technical Strategy for Malaria 2016-2030 (WHO, 2015a). Targets for the strategy for 2030 include reducing both malaria mortality and case incidence from their 2015 levels by at least 90%, eliminating malaria from at least 35 countries where malaria was transmitted in 2015 and preventing malaria re-establishment in all countries that were malaria-free. There has been renewed interest in the possibility of eradicating malaria, and a vision for achieving this through a science-supported endeavour with strong political leadership, perhaps by 2050, has been sketched out (Feachem, 2014; Moyer & Emde, 2012; USAID, 2015).

Yaws is a bacterial tropical disease of the skin, cartilage, and bones caused by *Treponema pallidum* subsp. *Pertenue* (Asiedu et al., 2008). Due to the high morbidity of treponemal diseases and the ease with which they responded to treatment with single dose depot penicillin, a 1949 WHA resolution to establish an expert group to study and make recommendations for further action led to yaws eradication campaigns run by WHO and UNICEF between 1952 and 1964 (Second World Health Assembly, 1949). This vertical programme reduced the number of cases by 95% but was then gradually dismantled in favour of integration into primary health care systems, with confidence that these would suffice to identify and treat the remaining 5% of cases. Ultimately, the lack of continued surveillance and waning of commitment and resources led to the resurgence of yaws in West Africa, Asia, and the Pacific in the late 1970s and global eradication of yaws was not achieved. Further half-hearted efforts in the 1980s to revive eradication efforts were not successful.

A viral infection with a high mortality rate and severe disfigurement and disability in survivors, **smallpox** began to be controlled following the discovery of the protective effects of inoculation with cowpox virus in the 18th century (Henderson, 2009; Miller, Barrett, & Henderson, 2006). Vaccination programmes in the 19th and 20th centuries eliminated the disease in many countries and the progress of an effort by the Pan American Health Organization beginning in the 1950s to eliminate smallpox from the Americas encouraged escalation to a global programme. In 1959 the WHA passed a resolution to eradicate smallpox, but initial progress was disappointing, especially in Africa and in the Indian subcontinent. In 1966 an international team, the Smallpox Eradication Unit, was formed at WHO under the leadership of Donald Henderson. In 1967, WHO intensified the global smallpox eradication, contributing US$ 2.4 million annually to the effort and adopting a new disease surveillance method (Fenner, Henderson, Arita, Jezek, & Ladnyi, 1988). The last naturally occurring case of smallpox was diagnosed in Somalia on 26 October 1977 and **the disease was certified as eradicated by a commission in December 1979**, endorsed by the WHA on 8 May 1980 (US Centers for Disease Control and Prevention, 1997). The smallpox eradication programme had significant lessons and legacies for

the EPI. Smallpox was, in some ways a special case as many attributes of the disease and the vaccine favoured eradication. In contrast to polio which is often asymptomatic, smallpox is identifiable through an easily recognized rash. Accurate surveillance therefore does not require laboratory diagnosis. The disease spread slowly so that transmission could readily be stopped by isolating the patient and vaccinating contacts within the area. The vaccine was also heat stable and required only a single dose to protect a person for a period of at least 5 to 10 years. Finally, vaccination was easily performed and protected immediately on application.

Infection with the **Guinea worm** (Dracunculus medinensis) in humans and dogs usually occurs through ingesting water contaminated with water flea larvae, leading to blistering of the skin from which the worm emerges during several weeks. There is no medication or vaccine against the disease. Prevention approaches include provision of clean water and use of a larvicide. In 1986, there were an estimated 3.5 million cases of Guinea worm in 20 endemic nations in Asia and Africa. In that year, the Carter Center Guinea Worm Eradication Program was initiated, with persistent championing by former US President Jimmy Carter. In collaboration with WHO, UNICEF, US-CDC and other partners the incidence of Guinea worm was reduced to 22 cases in humans and 419 in dogs across four African countries (Chad, Ethiopia, Mali, South Sudan) in 2015 and 11 cases in humans and 769 in dogs in 2016 by 22 August. It has been hoped that Guinea worm will soon become the first parasitic disease in humans to be eradicated (The Carter Center, 2016; WHO, 2016b, 2017a). However, the recent emergence of numerous Guinea worm infections in domestic dogs in Chad, probably due to their consumption of fish and fish entrails containing Guinea worm larvae, has presented a setback (Callaway, 2016). Important lessons of the Guinea worm eradication campaign have been highlighted (Hopkins, 1998; Richards, Ruiz-Tiben, & Hopkins, 2011; Sutton & Canyon, 2015). There have been major impacts on national economies in the endemic countries and the campaign also trained a new generation of health-care workers. Behaviour change has been another factor critical to the success of the campaign, achieved by a grassroots approach as a counterpart to the high-level prioritization of the issue by the ministries of health in endemic countries, as well as the support of the international partners (Tucker, 2012).

Eradication lessons, legacies and new initiatives

WHO initiated the **Expanded Programme on Immunization** (EPI) in 1974 with the objective to vaccinate children throughout the world (Henderson, 1984). EPI built on the smallpox eradication infrastructure and gained from the inspirational momentum that the successful eradication programme generated; however, in contrast to disease-specific eradication initiatives, routine immunization requires long-term sustainable approaches to protect new susceptible cohorts and monitor disease control with high quality surveillance (Miller et al., 2006; Okwo-Bele & Cherian, 2011). The

first diseases targeted by the EPI were **diphtheria, whooping cough, tetanus, measles, poliomyelitis and tuberculosis**. Global policies for immunization and establishment of the goal of providing universal immunization for all children by 1990 were established in 1977, as an essential element of the WHO strategy to achieve health for all by 2000 (WHO, 2013a). Coverage of the initially targeted infections has increased to at least 80 percent, and has also been expanded to include other vaccinations such as for **hepatitis B, Haemophilus influenzae type B, rubella, tetanus and yellow fever**. WHO works in partnership with other organisations, notably UNICEF and Gavi (Gavi, 2017; UNICEF, n.d.).

Writing on the 40th anniversary of the EPI, DG Margaret Chan (2014) reflected on the reasons for the EPI's success, which included:

- Prevention of childhood deaths has great public and political appeal, which had helped create momentum.
- Vaccines are scheduled interventions that can be delivered even in the absence of strong health systems.
- Costs of the initial six EPI antigens (for polio, diphtheria, tuberculosis, pertussis, measles, tetanus) were low.
- EPI had encouraged new models of international cooperation, found new sources of funding, and stimulated innovation in technology and the operational performance of national immunization programmes.
- EPI had pioneered improvements in surveillance and monitoring as a contribution to accountability for results.
- Fundamental public health capacities had been strengthened.
- The establishment of Gavi in 2000 helped launch the most innovative EPI decade to date.
- Commitment to fairness had always been a driving force. Gavi, with support from WHO, UNICEF, and others, had increased equitable access to newer, more expensive vaccines.

The EPI had carved out pathways and strategies to achieve universal access to immunization services and this legacy provided guidance for reforms that would move health systems towards universal coverage.

Other potential disease eradication targets

Considering the lessons from the big eradication campaigns, Yekutiel (1981) drew on the experience gained in the campaigns against malaria, smallpox, yellow fever and yaws which have led to a better

understanding of the complex factors involved in their success or failure. He proposed six preconditions as criteria for the decision whether to opt for control or eradication, but concluded that the outstanding feature of the campaigns for eradication had been the role played by socioeconomic factors – the importance of which has in general been consistently underestimated. Looking at the gross administrative deficiencies and operational flaws which, to a greater or lesser degree impeded all the campaigns, he argued that the fundamental misjudgement was the failure to recognize the spread of diseases as basically social phenomena, and the resulting eradication approaches focused on primarily technical and methodological problems. In Yekutiel's opinion, there were no suitable targets for disease eradication in the immediate future. In the case of polio, he considered it was best controlled by immunization, provided that this was accompanied by careful surveillance.

Nevertheless there has been a continuing interest in new disease eradication targets. In a review article in 2013, Hopkins noted that since the last case of naturally occurring smallpox in 1977, there had been three major international conferences devoted to the concept of disease eradication, with several other diseases having been considered as potential candidates (Hopkins, 2013). Among the candidates that have been considered as potentially eradicable are **lymphatic filariasis, measles, mumps, rubella and pork tapeworm** (Paauwe, 2009; The Carter Center, 2008).

Among these suggestions, **measles** has received most attention in recent years, buoyed by a history of temporary successes in the Americas (de Quadros, 2002; M. Miller et al., 2006). Comparing measles with previous eradication programmes, Keegan et al. (2011) reviewed the literature on the yaws, malaria, smallpox, guinea worm, and polio eradication programmes and compared enabling and constraining factors for each of the prior eradication programmes with the same factors that might facilitate or hinder global measles eradication in 2010. They concluded that a potential measles eradication programme would enjoy distinct advantages in comparison with earlier eradication programmes, including strong political and societal support, economic analyses demonstrating a high level of cost-effectiveness and a rigorous upfront process, compared with previous eradication initiatives.

In Chapter 1 of the Gates Annual Letter (2015), 'Child deaths will go down and more diseases will be wiped out', Bill and Melinda Gates pointed out that it is very difficult to destroy a disease and that it has only been done once in the case of smallpox in 1980. Nevertheless they predicted that with hard work, four diseases can be eradicated by 2030, saying *"we can get polio out of Africa this year and out of every country in the world in the next several years"*. The aim was also to eradicate Guinea worm soon *"thanks in large part to the leadership of President Jimmy Carter and the Carter Center"* and to see the end of diseases such as elephantiasis, river blindness, and blinding trachoma.

6. CONCLUSIONS

The historical trajectory of the GPEI has demonstrated that this unprecedented global health initiative has innovatively adapted to overcome many of the unforeseen barriers to success which have arisen during its nearly three decades of operation. The partnership's achievements on one hand, which can be attributed to its agility and perseverance, have been offset on the other by significant environmental and operational challenges. These challenges have included the epidemiology of the poliovirus; changing tides of political and financial commitment; and complacency in areas assessed as polio-free. As the world draws nearer than ever before to a successful conclusion of the GPEI's core mission, it is critical that all relevant stakeholders make the necessary political, financial and social commitments to ensure that polio is eradicated sustainably, and that the GPEI's diverse capacities in public health provision are not dismantled without alternatives in place.

The single greatest contribution that the GPEI can make to global health is to achieve eradication. This is not only because, as demonstrated by the above review, it makes sense economically, epidemiologically and ethically; it would also represent an incredible feat for, and positive contribution to global health governance. Achieving eradication is critical to the future positioning of the global health community. First, it will protect the world's investment, while providing exponential returns on the billions of dollars already dedicated to the cause. Second, it will lend credibility to a wealth of approaches, tools and strategies for the future navigation of the world's most complex global health challenges.

Beyond the GPEI's primary function of eradicating polio, existing literature has also highlighted the extensive impact and inherent value of the lessons learned, knowledge, and assets developed by the GPEI for global health more broadly. This recognition adds a certain complexity to the contemporary positioning and approach of the GPEI. As the Initiative approaches its inevitable dismantling, the global health community faces both an opportunity and challenge as it strives to maximize the impact of the GPEI's collective experience. In terms of the legacy of the GPEI, key actors will need to consider both resilience and transition. Resilience is key to ensuring that those communities which were once polio-affected will sustain the necessary capacity in surveillance and response to prevent poliovirus from resurfacing in future. Effective transitioning is critical to ensuring that the capacities, knowledge and assets associated with polio eradication activities are successfully and sustainably transferred or adapted to other global health priorities, initiatives and functions.

As leaders and influencers in many aspects of health governance, universal health coverage and health systems strengthening, European actors will be critical to the successful conclusion of the GPEI. Furthermore, their voices, as well as financial and political support are essential to ensuring that the sun-setting of the world's largest ever global health initiative is conducted in a sustainable, impactful and accountable way.

TECHNICAL ANNEX

Polio and vaccines

Poliomyelitis is a viral infection, usually limited to the gastrointestinal tract, nose and throat and often asymptomatic, but the central nervous system and spinal cord may be affected. It is most often recognised by the onset of acute flaccid paralysis (AFP), mainly affecting children under the age of 5. One in 200 infections leads to irreversible paralysis (usually in the legs) and among those paralysed 5-10% die when their breathing muscles become immobilized. There is no cure, but prevention is achieved with oral or injectable vaccines (Heymann & Aylward, 2004).

Three different serotypes (types 1, 2 and 3: requiring the development of separate antibodies to generate immunity) of the poliovirus occurred in the wild state. Type 2 has been eliminated in the wild (last detected in India in 1999) and there have been no cases due to wild poliovirus type 3 since one reported by Nigeria in November 2012 (WHO, 2016c).

Oral polio vaccine (OPV), developed in 1961 by Albert Sabin, is a 'trivalent' vaccine – a mixture of live, attenuated poliovirus strains of all three serotypes. OPV is effective, easily administered by volunteers rather than requiring trained health workers or sterile injection equipment, relatively inexpensive (in 2011, a single dose for public health programmes in developing countries cost 11-14 US cents) and induces long-lasting immunity to all three serotypes. For several weeks after vaccination, the vaccine virus replicates in the intestine, is excreted in the faeces and can be spread to others in close contact. Thus, in areas where hygiene and sanitation are poor, immunization with OPV can result in "passive" immunization of people not directly vaccinated. When OPV is administered there is competition to cause immunity among the three attenuated viruses, which results in unequal protection efficiency for each type. OPV is most effective against type 2 and three doses are needed to produce overall immunity in more than 95% of recipients (GPEI, n.d.-d).

In about 1 in every 2.7 million first doses of OPV vaccine, the live attenuated virus can cause vaccine-associated paralytic polio (VAPP). Also rarely, the vaccine poliovirus may combine with strains of another virus (Coxsackie), producing circulating vaccine-derived polioviruses (cVDPVs) which can lead to outbreaks of polio (Henderson & Klepac, 2013; Kew, Sutter, de Gourville, Dowdle, & Pallansch, 2005).

Monovalent oral polio vaccines (mOPVs), consisting of live, attenuated poliovirus strains of either type 1 or type 3 poliovirus alone, give protection against only one type of poliovirus. From 2005,

mOPVs were introduced to more rapidly interrupt the final transmission of poliovirus strains around the world, both having been introduced in India and Afghanistan initially and subsequently used in Nigeria, Pakistan and Chad. The mOPVs create much stronger immunity on the first dose compared with trivalent OPV (tOPV) and a higher proportion of children develop immunity after the first dose of mOPV than after the first dose of tOPV. mOPVs have been recommended for use in supplementary immunization campaigns in areas where only wild poliovirus type 1 or type 3 alone were circulating, but not as a substitute for tOPV in routine immunization programmes (GPEI, n.d.-c).

Bivalent oral polio vaccine (bOPV), consisting of live, attenuated wild poliovirus strains of type 1 and type 3, was first used in Afghanistan in December 2009, having been developed to improve the efficiency and impact of vaccination campaigns in areas where both types of poliovirus co-circulate. Its advantages include that it is at least 30% more effective than tOPV and almost as good as the mOPVs, yet delivering both at once and allowing countries to simplify vaccine logistics and optimize protection. In areas where access to children is limited, using bOPV helps maximise the impact of each contact with a child (GPEI, n.d.-d).

Inactivated polio vaccine (IPV), originally developed by Jonas Salk in 1955, is produced from wild poliovirus strains that have been killed with formalin. Given by intramuscular injection by a trained health worker, it can be administered alone or in combination with other vaccines (e.g., diphtheria, tetanus, pertussis, hepatitis B, haemophilus influenza). Generally three spaced doses are given to generate adequate levels of immunity to all three types of poliovirus and in most countries a booster dose is added during late childhood. IPV has been used successfully in the polio eradication programmes in a few countries, but until recently most countries used OPV (WHO, 2017b).

The GPEI's Polio Eradication and Endgame Strategic Plan 2013–2018 calls for a transition in the vaccines used to eradicate polio and requires the eventual removal of all OPVs to eliminate the rare risks of VAPP and cVDPV. This is especially important to reduce the risk of vaccine-related type 2 poliovirus infections (E. Miller & John, 2016). The withdrawal of OPVs has been planned to occur in a globally synchronized manner, starting in April 2016 with a switch from trivalent to bivalent OPV, removing the type 2 component from immunization programmes. Preparation for the removal of OPVs also included the introduction of at least one dose of IPV into routine immunization programmes in all countries and by April 2016, 94 out of 126 OPV countries had achieved this. The switchover to IPV is already under way in a number of countries, but the pace is being limited by a global shortage in the supply of IPV vaccine due to production difficulties, which is likely to persist until 2017-18 (WHO, 2016e, 2016f).

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