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A World Without Polio

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When this journal last published a special supplement on polio nearly 18 years ago, we lived in a world that was still deeply entangled with this devastating virus [1]. All 3 poliovirus serotypes were still circulating on four continents. Some of the world's largest countries remained mired in the disease, some with thousands of cases each year. Most tellingly, a number of polio-infected countries, particularly in Africa, had not even introduced core eradication strategies, such as polio national immunization days (NIDs). Both financial and human resources were stretched; worldwide, <250 people were employed full time in a program whose success would eventually require, at its peak, reaching and vaccinating >600 million children multiple times per year.

Despite these realities, optimism and enthusiasm were running high in 1997. Nelson Mandela himself had, just the previous year, launched the continent-wide Polio-Free Africa initiative accompanied by a Kick Polio Out of Africa social mobilization campaign. The massive Operation MECACAR was rapidly clearing virus from the 18 participating countries, spanning 2 continents and coordinating and collaborating through shared poliovirus surveillance, cross-border planning, and synchronized NIDs across the Middle East, Caucasus, Central Asian Republics, and Russian Federation. And in most of the world where the 4 core eradication strategies had been introduced, the number of both cases of polio-paralyzed children and polio-infected countries were falling rapidly (Figure 1). The sense that, with further program expansion, eradication might soon be inevitable was reinforced in 1999 by the eradication of the type 2 wild poliovirus serotype globally; that the last type 2 case was reported from Aligarh, India, suggested that eradication of the other

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serotypes would follow quickly, both in that country and globally. By 2000, 3 of the 6 regions of the World Health Organization (WHO) had seen their last indigenous poliovirus and were either already certified as polio free or soon would be. Although it was apparent that the original goal of completing wild poliovirus eradication globally by 2000 would be missed, the then Secretary-General of the United Nations, Mr Kofi Annan, convened a special Polio Eradication Summit in September of that year to ensure that the program remained on track for its secondary target of certification of global eradication in 2005. By 2001, polio had been reduced to 475 cases in 10 polio-endemic countries, compared with 350 000 cases in 125 polio-endemic countries in 1988.

But polio proved to be more tenacious and insidious than any had anticipated. Poliovirus transmission persisted in a handful of countries with weak immunization systems and low performing eradication activities, resulting in ongoing international spread and recurrent virus importations into previously polio-free countries. From 2003 to 2011, between 8 and 19 polio-free countries had to contend with poliovirus importations each year (figure 1 in the article by [2]). The WHO estimates that from 2003 to 2014, there were 191 new importation events into previously polio-free countries, resulting in 3763 reported cases of paralytic polio in 43 countries and costing $1.15 billion in additional funds from international organizations and agencies alone for outbreak control, not including the substantial but unquantified national resources allocated (see map on cover of this issue; unpublished data, World Health Organization, June 2014).

Resources had to be scaled-up immensely in the 2000s to achieve the population immunity levels needed to stop the virus everywhere. By 2005, the number of people employed by the program had grown 10-fold, to >2500, with the deployment of surveillance officers and supplementary immunization campaign planners down to the district and subdistrict levels in many of the most-dangerous and most-difficult operating environments in the world. Annual expenditures more than tripled and would soon reach US$1 billion a year as the remaining polio-infected countries, including those that had become reinfected, doubled and tripled the number of oral poliovirus vaccine (OPV) campaigns they were conducting to fill the immunity gaps left by weak routine immunization programs and poor quality NIDs. Still, poliovirus transmission persisted.

Amid the large and dense populations of Egypt and India, the remaining poliovirus serotypes continued to circulate, even in the face of high population immunity. In Afghanistan and Pakistan, lawless and insecure areas sustained indigenous transmission despite well-performing programs in other areas of both countries. In Nigeria, unfounded rumors that OPV was a plot to sterilize Muslim children brought that program to a halt for 12 months in key northern states during 2003–2004. From each of these problem areas, virus continued to spread internationally, resulting in thousands of paralyzed children and costing hundreds of millions of dollars for additional eradication activities. To make matters worse, by the end of 2005, not only were the remaining wild poliovirus serotypes 1 and 3 still circulating and paralyzing children, all 3 of the Sabin-strain polioviruses had proven capable of reverting to both neurovirulence and enhanced transmissibility, giving rise to new outbreaks caused by circulating vaccine-derived polioviruses.

Faced with these challenges, the feasibility of the program was increasingly questioned, with some commentators even calling for the goal of eradication to be abandoned in favor of control [3]. However, subjecting this epidemic-prone disease to control had by then proven to be a false premise. Outbreaks that permanently disabled or killed thousands of children, many in countries with moderately effective immunization programs, foreshadowed the devastation that future generations would face if the world were to abandon its commitment to polio eradication. The Global Polio Eradication Initiative (GPEI) has proven both resilient and adaptive to new challenges and constantly changing circumstances.

The articles in this supplement document what is perhaps the most extraordinary globally coordinated health program in history in terms of its magnitude and reach. In the face of the diverse, historic, and new challenges encountered in this millennium, the GPEI's spearheading partners, the WHO, Rotary International, the Centers for Disease Control and Prevention, and the United Nations Children's Fund, have responded with new tools, new tactics, new alliances, and new commitment, energy and endurance.

As polio disappears from the planet, the strategies and polio vaccination policy decisions that are required to finish eradication and to maintain a safe polio-free world in the posteradication era have grown more complex [4]. Today, the eradication program uses new bivalent and monovalent OPV formulations to enhance the impact of each immunization contact. OPV is delivered door to door to ensure, as Albert Sabin always advocated, that every house is "infected" with the vaccine. New advocates and stakeholders of international stature, such as those on the Islamic Advisory Group, have brought their voices to the eradication effort to ensure that all parents understand their obligation to ensure that their children are vaccinated with OPV every time it is offered. New government and private sector donors, such as the Bill and Melinda Gates Foundation and the United Nations Foundation, have brought substantial new financial and strategic resources to the table. A new collaboration has been forged with the GAVI Alliance to ensure that the inactivated poliovirus vaccine (IPV) may be introduced into routine immunization programs in every country worldwide, providing a safer and more affordable strategy for eventually withdrawing each of the oral polio vaccine serotypes. All of this is captured in the *Polio Eradication & Endgame Strategic Plan 2013–2018*, which charts a clear course for ending all polio forever [5].

These innovations and commitments are making a difference. In March 2014, the entire South-East Asia Region of WHO, including India, was certified as polio free, increasing from 50% to 80% the proportion of the world's population living in areas that have been certified as having interrupted their indigenous wild poliovirus transmission. Of equal significance, as of July 2014, 20 months had passed without detection of type 3 wild poliovirus anywhere in the world, suggesting that this serotype may now have joined type 2 poliovirus in having been eradicated. One of the key remaining polio-endemic countries, Nigeria, achieved a >50% decrease in the number of polio cases in 2013, compared with 2012, with cases in the first half of 2014 registering in single digits. Another sign of the increasing resolve of the global community to ensure the completion of polio eradication was the declaration by the Director-General of the WHO on 5 May 2014 that the international spread of polio in 2014 constituted a Public Health Emergency

of International Concern under the International Health Regulations (2005), with new vaccination recommendations for travelers from Pakistan and other poliovirus-exporting countries [6]. These recommendations are designed to require polio vaccination of residents of all ages prior to their departure from polio-exporting countries, to reduce the risk of international spread of polioviruses from infected areas into previously polio-free countries (Figure 2).

In this supplement, the articles have been organized under 6 topic headings. The first of these, “Acceleration of Eradication,” provides the latest information on global progress toward interruption of wild poliovirus transmission and the role of the Independent Monitoring Board of the GPEI in monitoring that progress. The next section, “Regional and Country Experiences,” offers a collection of country and regional reports on progress toward polio eradication and highlights both the technical and programmatic innovations used and challenges faced along the way. The third section focuses on the role of “Epidemiologic, Virologic, and Environmental Surveillance” as essential tools for monitoring progress and understanding the dynamics of polio outbreaks, including the use of state-of-the-art laboratory diagnosis and genetic sequencing to document poliovirus transmission pathways. The fourth section, “Risk Assessment, Mitigation, and Prevention,” describes the risks of vaccine-associated paralytic polio among healthy individuals and persons with primary immune deficiency disorders and the use of mathematical modeling to better define and manage population immunity and prevent poliovirus transmission. The fifth section, “The Polio Endgame: Preparing for the Post-Eradication Era,” explores the rationale and evidence supporting the endgame and posteradication vaccination policy changes, including introduction of IPV, as well as the development and potential role of poliovirus antiviral agents and an update on poliovirus laboratory containment. The final section of the supplement, “Beyond Polio Eradication: Immunization and Health Systems and Legacy,” deals with what lies ahead, including how to use the knowledge, experience, lessons learned, and assets of the GPEI to forge stronger and moresustainable routine immunization and primary healthcare systems going forward and, more generally, how best to apply the lessons learned and assets of GPEI to other global health priorities.

Times have changed a great deal since the World Health Assembly launched the GPEI in 1988 and since *The Journal of Infectious Diseases* last reviewed progress and prospects in 1997 [1]. Progress has been hard fought indeed, but the prospects for completing the eradication of polio and securing this victory forever are now better than ever.

Disclaimer.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the World Health Organization.

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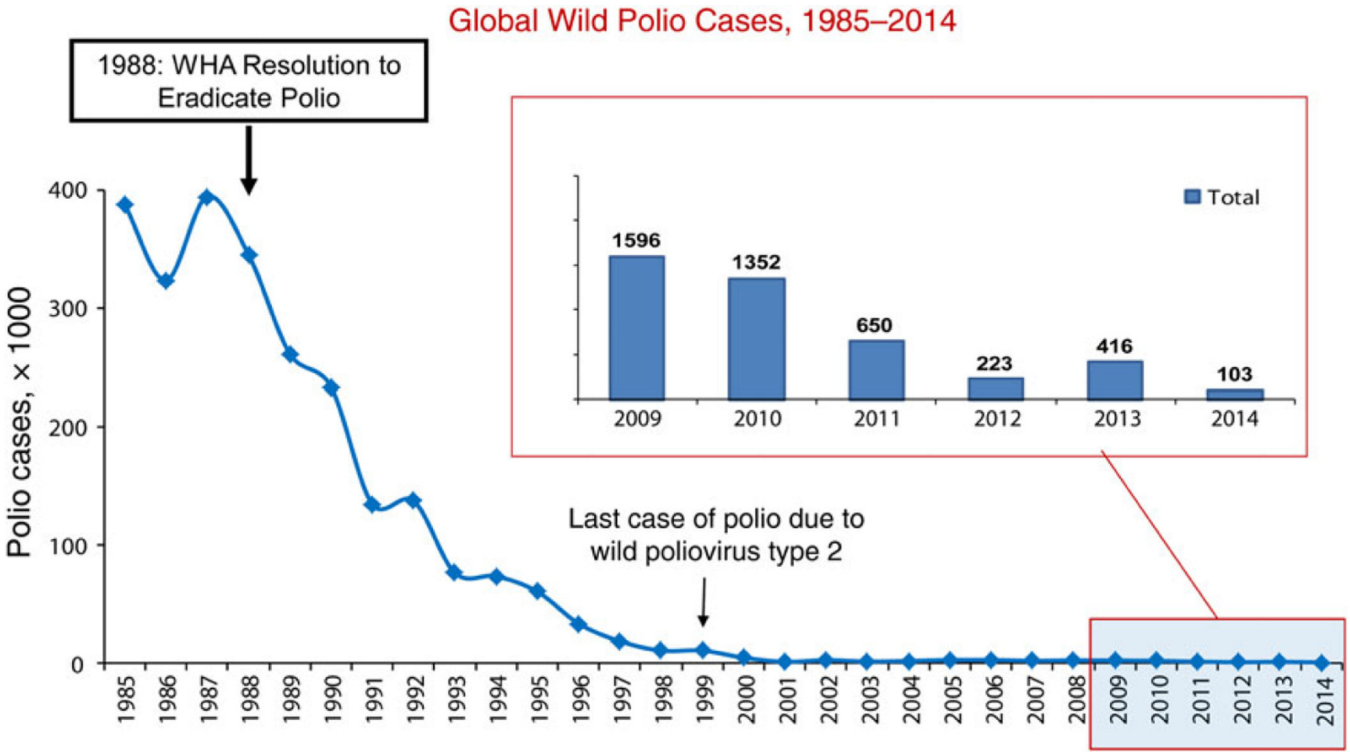

Figure 1.

Global wild poliovirus cases, 1985 through 18 June 2014. Values are unpublished data from the World Health Organization polio database. Abbreviation: WHA, World Health Assembly.

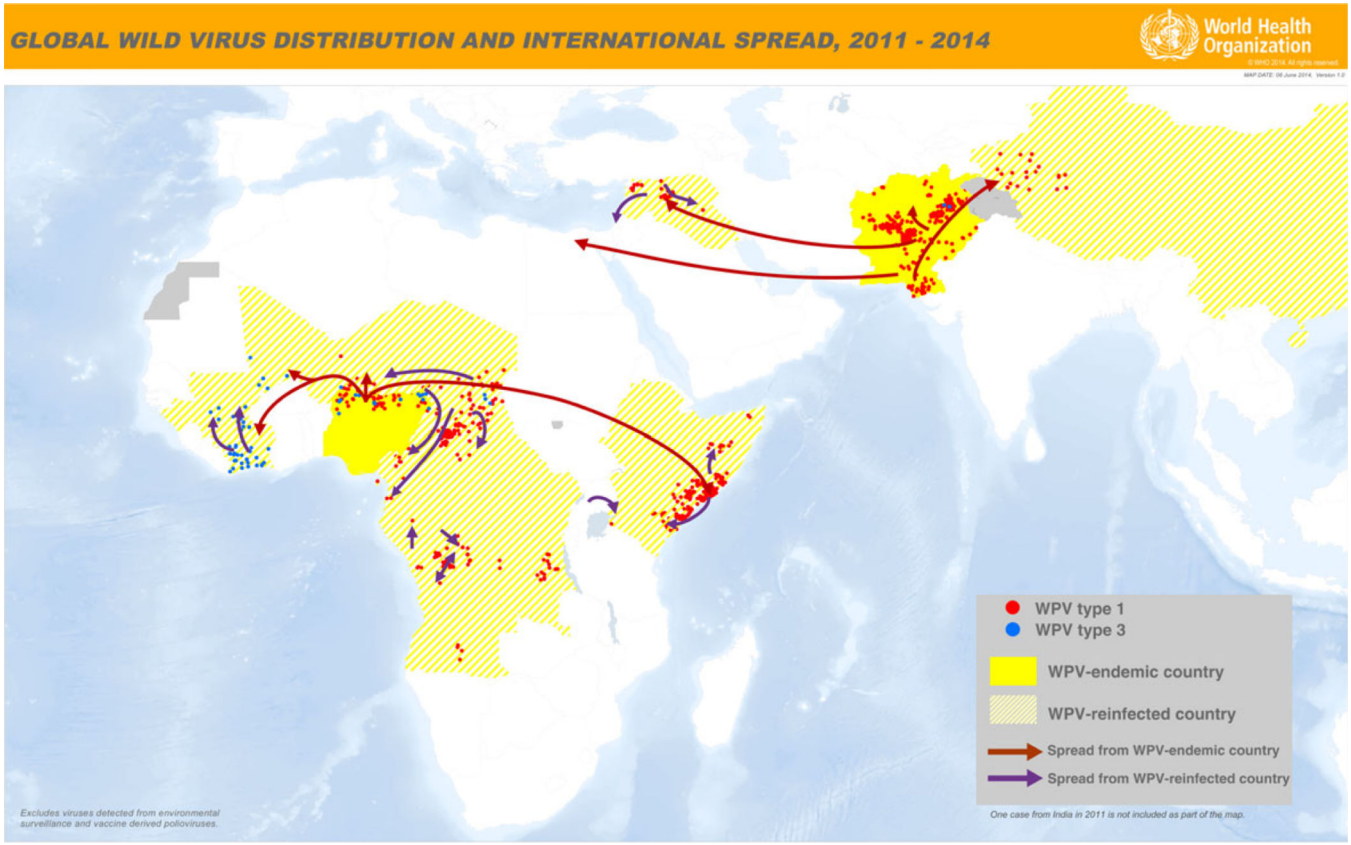

Figure 2.
Global wild poliovirus distribution and international spread, 2011–2014.