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Title: Polio Eradication’s Moral Dilemma

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**Abstract**

During the last 5 years, globally, polio caused by vaccine viruses has outnumbered polio caused by natural (wild) polioviruses, posing a moral dilemma. Public health ethics should ensure the best interests of the community, with equity in sharing benefits and risks irrespective of socioeconomic disparities. Vaccine viruses in oral polio vaccine (OPV) cause vaccine-associated paralytic polio (VAPP), and also polio caused by vaccine-derived polioviruses (VDPVs). By its policy of the use of OPV in low and middle income countries, while rich countries use the safe inactivated polio vaccine (IPV), the global polio eradication programme has created social injustice. In 2017 and 2018 there were outbreaks of polio in Syria and Papua New Guinea due to circulating VDPVs, after many years of remaining free of polio due to wild polioviruses. The only ethical way forward is to replace OPV with IPV in all countries.

**Keywords:** Polio eradication, Public health ethics, VAPP, VDPV, Papua New Guinea, Syria

**Introduction**

Healthcare ethics is patient-centred, medical research ethics subject-centred and public health ethics community-centred. There is a misconception that ethics is not relevant in public health as its interventions are preventive, perceived public good and mostly without harm. However, the beneficiaries are members of the community and their best interests are at the core of public health ethics. Since individual members of the community are passive participants, generally uninformed and vulnerable to any misadventure, public health providers have a special responsibility for protecting the interests of all members of all societies in all countries wherein any public health intervention is employed.

Disease eradication is public health with humanitarian and idealistic goal. Traditionally, socioeconomic development is the pathway to good health of the people. The world has waited more than a century for an acceptable level of development in low income countries – but without satisfying success. The development pathway to good health is disappointingly too slow.

Disease eradication can remove a pathogen without waiting for development to succeed. Smallpox eradication illustrated this model – international efforts resulted in eradicating the virus of smallpox, thereby ensuring the benefit of no more smallpox in all countries, rich and poor. Disease eradication is thus the acme of public health ethics – providing absolute equity in sharing the benefit. Fortunately smallpox vaccination was almost completely safe from serious adverse reactions except in persons with eczema or immune deficiency. Since vaccination could be discontinued once smallpox was eradicated, any risk for anyone from the vaccine was automatically removed.

The intention of the World Health Assembly resolution to eradicate polio, passed in 1988, was to repeat the humanitarian and idealistic goal for the benefit of all children of the world, irrespective of their socioeconomic disparities (1).

However, equity in sharing benefits and risks in polio eradication programme has not become a reality, which highlights out a moral dilemma. Social justice, the very aim of disease eradication programme, has been compromised. We explore the reasons behind this problem and suggest an ethical way forward.

**Natural polio and programme-induced polio**

From 1988 till 2015, the Global Polio Eradication Initiative (GPEI) maintained the policy of the exclusive use of oral polio vaccine (OPV). The alternative injectable polio vaccine (IPV) was not only not used, but also actively discouraged in OPV using countries (2). Public health ethics demands that any intervention applied widely should be fully backed by sound science (3). There was no scientific evidence that exclusive use of OPV was essential or sufficient for polio eradication as no country in the world had been able to eliminate polio by the exclusive use of OPV. All countries that depended on OPV for the purpose achieved elimination only after introducing IPV, since OPV itself is a cause of polio. OPV has two flaws, related to its safety and efficacy.

The safety problems of OPV were well recognised right from 1964 onwards. OPV caused, occasionally, vaccine associated paralytic poliomyelitis (VAPP) in the vaccinated and in their close contacts (contact VAPP) and also ‘community-acquired VAPP’ due to the circulation of genetic revertants of vaccine viruses (4). Vaccine viruses were known to be genetically unstable and also transmissible, two most unwanted properties of any live vaccine. The efficacy of OPV was not satisfactory in India and many tropical developing countries, resulting in vaccine-failure polio due to wild polioviruses in large proportions of children given 5-7 doses or even more, by itself ethically wrong (5).

On the other hand, IPV had been consistently shown to be completely safe and completely effective. Excluding IPV from the public health interventions contravened public health ethics (5).

In 2000, an outbreak of circulating vaccine-derived poliovirus type 1 (cVDPV-1) was documented in Hispaniola in the Caribbean (6). Indeed, this was not the first time cVDPV had emerged – in Egypt a vaccine-derived type 2 virus had circulated for ten years, until it was interrupted in 1993 (7). These gave the clear signal that the OPV-only policy of GPEI was in urgent need of revision. The imperative was to introduce IPV and expand its use universally. That was not done because of the faulty application of science – that OPV alone was able to eradicate polio. On the contrary there was ample scientific evidence that IPV alone was sufficient to eliminate polioviruses in several countries. The consequences of the unscientific vaccine policy continue to affect children developing polio due to vaccine-derived viruses in many countries. We present two examples below.

Papua New Guinea (PNG) had successfully eliminated natural (wild virus) polio 18 years ago. However, according to policy, PNG had to continue distributing OPV to children, exposing them to the risks thereof OPV. We do not know if VAPP had occurred as it was not being counted in any OPV-using country. Eventually, in 2018, when OPV coverage had declined to 60%, a large polio epidemic occurred that paralysed 26 children, caused by cVDPV-1 (8). The magnitude of the epidemic, in terms of total number of children infected with cVDPV-1 is unknown, but could be as large as several thousands, considering the very small case-to-infection ratio. In 2018 there were a total of 104 cases of programme-induced polio caused by cVDPVs while Pakistan and Afghanistan together had only 33 cases of polio due to natural type 1 poliovirus (9,10). The question is: if Pakistan has wild type 1 polio, why should PNG suffer from vaccine-induced polio? Does a public health programme, however lofty its intentions, have the moral right to let loose a virus that may cause an outbreak of the disease on eradication agenda?

In 2017, Syria had a programme-induced type 2 epidemic of polio that paralysed 74 children, when OPV coverage had fallen to 53% (11). It was the largest recorded single cVDPV- 2 polio outbreak. The magnitude of the infection epidemic would have been a lakh or more as the case-to-infection ratio is even smaller than that of type 1. Syria has not had any natural polio for nearly 2 decades, but had to continue OPV. Natural type 2 virus had been globally eradicated in 1999; the programme-induced type 2 outbreak 18 years later in Syria poignantly illustrated the moral dilemma of an eradication programme meant for equity in sharing benefits and burdens. For comparison, in 2017, globally the number of natural polio was 22 and that of cVDPV polio 96 (12).

Every year, the numbers of global wild polio virus WPV and cVDPV cases are published by the Centres for Disease Control and Prevention (CDC) and GPEI but VAPP cases are not similarly counted (13-21). cVDPVs are VDPV isolates for which there is evidence of transmission in the community.

Apart from cVDPV, OPV also causes polio due to immune-deficiency associated VDPV (iVDPV) and ambiguous VDPV (a VDPV). These are neurovirulent revertants of oral polio vaccine viruses without evidence of circulation – iVDPVs are isolated from persons with primary immunodeficiency (PID) and aVDPV are isolates from individuals or from environmental samples.

We have data from CDC publications for the years 2014 through June 2018, presented for 18 months, 18 months, 17 months and 15 months respectively, with 3-6 months of overlaps in each report. We have calculated per month averages from each report and multiplied with 12 to arrive at estimates in the years 2014 through 2018 as 5 cases of iVDPV cases and 11 cases of aVDPV cases per year.

India had 100-200 cases of VAPP per year prior to the switch from tOPV to bOPV, in April 2016 (22) with average of annual 150 in 2014 and 2015 (i.e about 12 per month). In 2016, the withdrawal of type 2 OPV and introduction of single dose of IPV could have caused at least 50% reduction in VAPP. It had been predicted that post switch, the reduction of VAPP could occur to the tune of 80-90% (23). But due to global IPV vaccine shortage and delay in implementation of IPV in India’s national immunisation programme till 2019 (24), we have considered at best 50% reduction in VAPP. Therefore, if we consider monthly cases of 12 for first 4 months and 6 for remaining 8 months, the VAPP cases for 2016 add up to 96. If we extrapolate this Indian data to the global statistics which is roughly 5 times, as India’s population is roughly one fifth of the population of developing countries (25), we can assume about 750 VAPP cases occurred during the years 2014 and 2015, 480 in 2016 and post switch roughly 360 in 2017 and 2018.

Based on this mathematical construct, if we combine the cVDPV, iVDPV and aVDPV plus VAPP figures, we see disturbing numbers of polio cases caused by the continued OPV-based eradication programme (Fig1). It is essential to reiterate the fact that all these cases are clinically no different from the polio caused by natural polioviruses.

**Fig1 :** Annual numbers of polio due to wild polioviruses(WPV) and estimated numbers of polio due to vaccine viruses (cVDPV, iVDPV, aVDPV and VAPP).

**The way forward for India and for the world**

Globally, some 50 countries have no risk of programme-induced polio, as they rely on IPV which has no risk of vaccine-associated polio while the rest of some 140 countries are at risk of programme-induced polio. What happened in PNG could happen in India, if the immunisation coverage with OPV slips from the current level. Thankfully type 2 vaccine virus was withdrawn from use in 2016, but that was unfortunately 12 years after it was due (26). Hopefully what happened in Syria will not happen anymore anywhere else.

There is an alternate pathway to ensure that no such risk threatens countries like India. India currently gives 2 intradermal fractional doses of IPV at ages 6 and 14 weeks, in lieu of the recommended one full dose intramuscular IPV at 14 weeks. India must include a full immunising schedule of IPV in the Universal Immunisation Programme. Two full IM doses given at 14 weeks and at 9 months will suffice. Once a reasonably high coverage is achieved, say 85% or more, OPV could be discontinued to remove any future programme-induced polio. From the year 2000 several countries have shown the way by discontinuing OPV and relying exclusively on IPV.

The 2-dose schedule can only be, for practical reasons, given using stand-alone IPV. On the other hand a combination vaccine containing IPV, namely a hexavalent vaccine, could be given in a 3-dose schedule, without altering the timings of current practice of giving pentavalent vaccine.

This approach is also valid for all countries currently using OPV. The earlier the use of OPV can be discontinued, the sooner the eradication programme can become free of the ethical dilemma.

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