Prioritizing polio

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"…if eradication is possible, it is more cost-effective and humanitarian than control."

We are only US$945 million short of successfully eradicating poliomyelitis: here, a case for why polio eradication should be made a priority worldwide is made – a proposal that is both economically viable and important for health care initiatives in the future.

With only 128 cases reported in 2012 (by 6 September 2012) compared with 356 in 2011, we have come closer than ever before to successfully eradicating poliomyelitis [101]. The Global Polio Eradication Initiative, which has worked on the worldwide eradication of polio, is, however, US$945 million (€724 million) short of the funds necessary to fully implement the campaign through 2013 [101]. The funding shortage has already forced essential vaccination activities in 24 high-risk countries to be scaled back or even to be cancelled, putting millions of children at risk [1,101]. It is crucial that public as well as private institutions make it a priority to sustain the current eradication effort so that polio can be eradicated in the only three remaining countries where the disease has been endemic, that is, Afghanistan, Nigeria and Pakistan, and so that it does not recur in neighboring countries such as India. An important study estimated in 2011 that eradicating polio would provide net benefits of $40–50 billion (€30–€38 billion) if the transmission of wild polio viruses were interrupted by 2015 [2]. 85% of these savings would benefit low-income countries [2].

Comparing preventive initiatives

To put the expected cost of polio eradication in perspective, it is instructive to consider other preventive initiatives and their respective per person cost. Traditional vaccines provided by the Expanded Program on Immunization cost $223 (€170) in sub-Saharan Africa and South Asia and $3634 (€2765) in Europe and the USA [102]. The legislation of the European Union, for example, accepts costs around €1 million ($1.3 million) per person for the prevention of death due to road traffic accidents [103]. This is officially referred to as the 'one million Euro rule' [103]. In the USA, the National Highway Safety Administration calculated the cost to society for each fatal motorcycle accident to be around $1.25 million (€0.95 million), providing a solid economic argument for preventive measures [104]. Death of course is not the only outcome of illness and accidents.

Table 1 shows the accepted costs for interventions that directly improve peoples' health or promote healthy living, and thereby enhance a person's quality of life. Here, cost is measured by quality-adjusted life year, a parameter that, though not standardized, is often used to measure and compare the cost–effectiveness of health initiatives, independent from any specific illness or cause [3]. Quality-adjusted life years take into account both the quantity and the quality of extra life provided by the healthcare intervention. It is the arithmetic product of life expectancy and the quality of remaining life years [4].

Barriers to funding

It is widely accepted that large annual investments are undertaken for the prevention of fatalities in traffic or sporting accidents, despite the fact that the public perceives such accidents as low risk [5].

Keywords: benefit • cost • eradication • Nigeria • poliomyelitis • prevention • vaccination

Table 1. Estimated costs per quality-adjusted life year for different preventive initiatives.

Preventive initiative	Cost per quality-adjusted life year	Ref.
Hemophilus influenzae type B vaccination of toddlers	Cost saving	[15]
Physical activity program for adults 'Be Active'	US$637 (€484)	[16]
Intensive tobacco-use prevention program for seventh- and eighth-graders	US$23,000 (€17,480)	[15]
Implantation of cardioverter–defibrillators in appropriate populations	US$52,000 (€39,521)	[15]
Mandatory 20 mph zones	US$137,828 (€104,685)	[17]

Costly public health programs are also societally accepted if they improve the quality of life. Comparatively small investments for the eradication of polio in contrast are now facing eminent failure because of a funding shortage, even though its public impact is arguably much higher.

It is notoriously difficult to obtain adequate funding for vaccination programs. The primary reason for this is that the positive health impact created by the vaccine is not actually perceptible to the beneficiary [6]. While stakeholders and decision makers tend to cite cost–effectiveness thresholds when arguing in favor or against implementing a new program or strategy, the result is not necessarily in tune with the cognitive nonmonetary factors that drive risk perception in the general public.

Unlike risks that are perceived as 'natural' and more or less random such as an acute respiratory infection or a rail travel accident [105], risks associated with vaccines are often misunderstood to be 'artificially induced'. If a child suffers from an adverse event after the administration of a vaccine, parents tend to blame themselves for vaccinating the child [6]. Familiarity with the event, its perceived catastrophic potential, the degree of control over the event and an understanding of the event as either 'natural' or 'human-made' will determine risk assessment [5,7].

With effective polio vaccines available to date, the threat of the disease itself has vanished in many parts of the world and public attention has shifted to the fear of adverse events following immunization. However, if public trust can be maintained long enough to achieve eradication, the disease will be eliminated along with the need to immunize against it [8].

Broader benefits of polio surveillance & immunization

Gains from polio eradication initiatives are not only monetary. The polio program for example trained an enormous cadre of staff that understands basic health needs and can provide services to people in the poorest areas in the world. Polio eradication initiatives also helped to improve public health at large and increased the effectiveness of other preventive programs.

More specifically, the initiative prompted the construction of infrastructure that allows for more efficient detection of suspected cases, facilitates the administration of the polio vaccine, as well as the collection, processing, and diagnosis of specimens. As a result, more than 90% of children in most areas worldwide have been vaccinated against polio. The delivery of other health tools has also benefitted from the improved polio infrastructure, ranging from the coadministration of vitamin A to the suspension of bed nets against malaria and immunizations against measles and other infectious diseases [101]. The process of eradicating polio has so far taught several lessons that could be adapted and implemented for the eradication of other disease conditions in low resource settings as follows:

- Initiation of strong disease surveillance activities as soon as the disease outbreak is confirmed;
- Implementation of a time- and target-oriented campaign;
- Improved communication that enables immediate action when necessary;
- Introduction of new methodologies for the rapid differentiation of organisms;
- Social mobilization during immunization campaigns, which provided effective solutions on how to reach out to medically underserved communities, how to map out where high-risk children live and how to reach out to them, even in the worst performing areas.

Local specificity: the case of Nigeria

After studies identified operational as well as social reasons for the shortcomings of past disease eradication programs, more value has been placed on understanding community practices and beliefs. As a lesson learned from smallpox eradication programs, vaccinators and short-term personnel are specifically trained to address cultural and regional aspects of vaccine acceptance [9].

Government organizations, public partnerships and local leaders are now all involved in ensuring comprehensive data management, analysis and reporting. As a result, the political commitment to eradicating polio is rather strong. The situation in Nigeria illustrates quite well how collaborative efforts can succeed: Nigeria witnessed a 95% decline in reported polio cases from 2009 to 2010 [101]. The improved quality and coverage of immunization activities resulted from very strong involvement of political, traditional and religious leaders down to the community level in the highest risk states as well as Local Government Areas (LGAs) contributing to this success.

Unfortunately, the progress registered in 2010 was not sustained in 2011 as Nigeria experienced persistent transmission of subtypes 1 and 3 of wild-type poliovirus, with a threefold increase in cases due to wild poliovirus as compared with 2010. In addition, three cases of circulating vaccine derived poliovirus type 2 were detected [101]. The funding gap makes it very hard to solve operational inefficiencies, for which effective solutions are available. Surveillance activities are often poor but could easily be enhanced. During Expanded Program on Immunization campaigns or routine immunizations, significant numbers of

susceptible children in the northern states of Nigeria are still not being reached by vaccination teams but they could be reached if more efforts were directed to social mobilization. Social mobilization could also help to counteract the negative rumors and misconceptions about the polio vaccine. To date, several areas in the north are politically unstable but Global Polio Eradication Initiative efforts there could be made safer and more effective if the expertise of local and non-governmental organizations could be employed with the proper incentives.

With stronger leadership and more accountability on the operational level, with more well-trained as well as motivated staff in the highest risk areas, and with an enhanced surveillance system it will be possible: to know the status of wild poliovirus intervention and the role of surveillance at any point in time to interrupt the transmission of the virus; to achieve highest quality acute flaccid paralysis surveillance by standardized acute flaccid paralysis indicators, genetic sequence analysis and environmental surveillance; to ensure implementation of high quality supplemental immunization activities with particular focus on high risk states and LGAs; and to increase poliovirus vaccine coverage in the highest risk LGAs to at least 50% by the end of 2012.

As new approaches for polio eradication are designed (**Box 1**), they too must be tailored to each country specifically to tackle persistent local challenges and to improve the performance of vaccination campaigns.

Eradication versus control

Scholars have pointed out that global decisions on disease eradication should be based on careful consideration of opportunity costs, with the objective of providing the most appropriate, cost-beneficial and equitable outcome of disease control [10]. In theory, policymakers may face the choice between eradicating a disease and controlling it. Studies have, however, shown that if eradication is possible, it is more cost-effective and humanitarian than control [11].

As we learned from the eradication of smallpox in the 1970s, the eradication by immunization is affordable and the savings continue to add up year by year once the disease has been eradicated successfully [12]. The cost–benefit ratio in the case of smallpox was 1:450 [12]. Approximately $300 million ($500 million in today's terms; €229 million nominally, €382 million in today's terms) sufficed to completely eradicate smallpox in less than 10 years [13]. The Center for Global Development determined that the USA "saves the total of all its contributions (to smallpox efforts) every 26 days because it does not have to vaccinate or treat the disease" [102]. One might argue that at least the savings that have already been made after the successful eradication of smallpox could now be invested in the eradication of polio.

If polio is not eradicated but rather continues to be controlled, ongoing polio surveillance will require extensive financial and operational efforts [12]. Furthermore, we will witness a rapid increase in polio cases if we only rely on routine immunizations. The Global Polio Eradication Initiative estimates that without eradication efforts, 200,000–250,000 cases of polio would be diagnosed per year, causing four million children to be paralyzed over the next 20 years [101].

Luckily, the public has shown low tolerance for preventable risks [14]. Global polio and guinea worm eradication efforts are underway. Regional eradication of measles and rubella has been achieved in the Americas and Australia. If these efforts succeed, there will be renewed confidence in the viability and value of disease eradication, and current debilitating diseases such as lymphatic filariasis, measles, mumps, rubella, yaws, schistosomiasis and some day even malaria may eventually be defeated by future campaigns.

Five-year view

On 27 September 2012, world leaders, donors and experts gathered at the UN Convention to unite behind a final push to eradicate polio, a crippling and potentially fatal disease. Key stakeholders including institutions such as the WHO, UNICEF, the Bill and Melinda Gates Foundation and others pledged to join forces to prioritize polio eradication.

If current campaigns to eradicate poliomyelitis succeed, 14 million lives can be saved in 3 years time [106]. The interruption of the transmission of wild polioviruses by 2015 would generate

Box 1. Vaccination strategies to support polio eradication.

- The polio eradication plan is to switch from the trivalent (covering three subtypes) oral polio vaccine (OPV), currently the vaccine of choice in most countries, to two vaccines: a new bivalent (covering two subtypes) OPV for routine immunization, backed up by judicious use of inactivated polio vaccine (IPV).
- OPV is less effective in children in the developing world. Reasons for this lower efficacy include tropical enteropathy, malnutrition and/or immunodeficiency, interference with serum antibodies, alterations in the gut microbiota, genetic susceptibility, interference by infection with endogenous enteroviruses, or coadministration of oral rotavirus vaccines [18–22]. In addition, problems with cold chain maintenance may cause damage to a live virus vaccine.
- The bivalent OPV is at least 30% more effective than the old trivalent OPV against polioviruses types 1 and 3 but does not contain live type 2 poliovirus, which caused most of the outbreaks of circulating vaccine-derived poliovirus.
- IPV, which is administered through injection, provides immunity to all three types of poliovirus but, unlike the oral vaccine, does not cause vaccine-derived polio because inactivated polio strains are used in IPV.
- Unlike the oral vaccine, IPV does not invoke intestinal immunity (local immunity in the gut) needed to stop the transmission of polio viruses. A child vaccinated only with IPV would not develop disease after contact with polioviruses but could still excrete the virus in the stool, perpetuating the circulation of polio virus within a population.
- One dose of bivalent oral vaccine followed by parenteral IPV booster will thus provide a better mucosal immunity in the gut while eliciting a long lasting memory response [101].

savings of at least $40 billion (€30 billion), 85% of which would benefit low-income countries. If polio is not eradicated, but merely continues to be controlled, ongoing polio surveillance will require extensive financial and operational efforts.

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B Rath, S Kochhar, W Maurer and C Elemuwa initiated the article; B Rath, S Kochhar, Mohammad Ali, W Maurer, C Elemuwa and F Bouder drafted the manuscript. I Chitwood, B Rath, S Kochhar, M Ali, F Bouder, E Mworozi, S Diedrich and A Khamesipour critically revised the manuscript for important intellectual content. I Chitwood and B Rath conceived the article design. All authors gave final approval for the version to be published, had full access to the entire text and content and take responsibility for the integrity of the data and interpretation.

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