1. Introduction

“Why has globalization—a force that has brought so much good—become so controversial?” asked Joseph Stiglitz, former World Bank Chief Economist, in 2002 (1). In the area of global health, the answer may be related to the previously espoused high expectations that were never realized. One example is the delay of global polio eradication led by the World Health Organization (WHO). Over the last 20 years, most countries around the world have become polio-free. Yet, a few nations in sub-Saharan Africa and South Asia have been unable to stop transmission and remain infected (Figure 1). In these geographical regions, the promise of globalization has not brought the promised economic benefits, which would have included better education and health services and resources, including the eradicating of polio. While globalization has arguably benefited a few developing nations in East Asia, Middle East and Latin America, these regions in South Asia and sub-Saharan Africa have been regrettably left out of the gains.

In an attempt to correct the stalled polio eradication efforts, which have already cost $5 billion the WHO Director-General, Dr. Margaret Chan, announced a call in February, 2007 for an “urgent stakeholder consultation on the case for interrupting wild poliovirus globally within 24 months”. With an additional call by the 60th World Health Assembly for polio eradication by 2009, an all-out global effort has been renewed by the member states and collaborators. Yet, in the wake of globalization, the difficulties being observed in the polio eradication efforts may reflect the slow progress of the health-related Millennium Development Goals (MDGs) no. 4, 5 and 6 in specific geographical regions (2,3). Notably, the world’s highest under-five mortality rate (U5MR) has been recorded in sub-Saharan Africa, which suffers under extreme poverty (Figure 2, Table 1) (4). Regarding this situation, in August 2007, WHO issued the World Health Report 2007, entitled “A safer future: global public health security in the 21st century”, stressing the importance of interdependence among health activities (5). Can the polio endgame be linked to the MDG no. 4 program through globally coordinated efforts? Such linkage could facilitate the stated endgame objectives, while further benefiting global health.

Here, we discuss the issues of global health disparities and polio-specific problems, and propose a new immunization initiative for vaccine-preventable diseases in sub-Saharan Africa, which urgently needs such action.
on several factors: systemic failures (corruption, unfair election systems, incompetence, failure to compete or properly select priorities, etc.), poor education (low literacy, difficulty in industrial and commercial development, brain drain), gender inequality, and, importantly, lack of critical media (7). For example, when seen from space, sub-Saharan Africa and rural northern India, at night is unlit—"as dark as all but empty Siberia" (8). In addition, while the economic development of India has been justly praised, there are concerns that the "failure to reform bloated civil services is putting the country's huge economic achievement at risk" (9).

Over the last two decades numerous attempts to foster health-related development have been made by multilateral, bilateral and philanthropic aid programs. However, many nations have instead seen decreasing health standards and along with ever-increasing external debts, which eventually had to be forgiven by governments and aid organizations (1,7).

At the village level in these areas, life is extremely difficult. Negative influences include lack of clean water, scarce health facilities and low primary school completion rates. Above all, the people are fully preoccupied with basic survival needs. 

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of cold chain devices, and inadequate facilities for laboratory especially for acute flaccid paralysis (AFP) surveillance, lack of transport, logistic difficulties for vaccine supply, shortage of cold chain devices, and inadequate facilities for laboratory examination of stools from cases of AFP. Thus, the vicious cycle of disease and poverty has stalled eradication efforts in South Asia and sub-Saharan Africa, where populations of extreme poverty (living less than $1 per day), comprise 30 and 46%, respectively. Here, it should be noted that, to be done successfully, as in the case of smallpox, eradication requires effective, short-cut interventions to minimize or reduce the causes of the health hazard to zero with use of special technology. In the case of polio, this means, immunization.

In this case, how are these two regions progressing with this technology?

3. Special technical problems

There are several technical issues affecting polio eradication efforts. The Sabin virus used for oral polio vaccine (OPV) is genetically unstable. Over the last three decades, a massive genetic flow of the Sabin strain has occurred in the global human population. OPV immunization, although rare, has resulted in reverted neuropathogenicity, including a transmissible circulating vaccine-derived poliovirus (cVDPV); immunodeficiency-associated VDPV (iVDPV) and ambiguous VDPV (aVDPV) (11). The WHO Polio Update, 22 January 2008, reported 172 outbreak episodes caused by cVDPV in 9 nations, 3 in sub-Saharan Africa, 5 in South and East Asia and one in Central America, from 2000 to 2007 (12).

It appears that continued use of OPV can actually re-seed wild polio into previously polio-free areas. For example, the Nigerian polio outbreaks caused by type 2 cVDPV are of concern and lead us to advocate further intensive research, if we want to ascertain the success of polio eradication (13). In Nigeria, the use of monovalent-OPV (mOPV) type 1 and type 3 in 2006 and 2007 effectively reduced the transmission of both types and may have accelerated the extended transmission and recombination of type 2 cVDPV with other species C non-polio enteroviruses in poorly vaccinated areas of only 30% vaccine coverage. In this area, type 2 wild poliovirus has not been discovered in recent years, hence the return of type 2 VDPV. The current AFP surveillance should be intensified to study whether or not type 2 cVDPV outbreaks have occurred elsewhere or will be occurring in any region, and whether trivalent-OPV or mOPV is being used in poorly vaccinated areas. The transmission and phenotypic features of type 2 cVDPV should be understood in comparison to those of the wild-type virus. If possible, it is warranted to estimate the extent of subclinical infection caused by type 2 cVDPV.

A similar research approach may be applicable to type 1 and 3 cVDPV. Further, while the current laboratory method to differentiate wild virus and Sabin virus isolates should continue, at the same time, we should critically investigate the definition of 1% divergence from the original Sabin and its epidemiological significance. How long will it take to obtain reasonable results from such research? Finally, how long and with what strategy should we continue post-eradication verification work? Recent events, like the discovery of VDPV even in Minnesota, a northern state of the United States, as well as discovery of wild subclinical infection in Canada in 1993, suggest that the polio-free status defined by the current AFP surveillance system needs to be revisited (14, 15). It would not be too difficult to determine the absence of wild poliovirus except in areas that are inaccessible and/or fraught with armed conflict, but the risk of imminent return of poliomylitis via VDPVs in regions of past eradication may be difficult to assess. These issues arise both in areas having good surveillance quality and also in areas of uncertain surveillance quality, such as the war-torn nations of Iraq, Afghanistan, Chad, Kenya, the Democratic Republic of Congo, Somalia and Sudan (Darfur).

Lastly, wild poliovirus can be synthesized in a laboratory with rather ordinary laboratory skills. The implications of this fact are complex, including problems in relation to biodefense (16). This finding has reduced the value of planned containment of laboratory poliovirus for obvious reasons.

All these discussions are related to the critical decision, namely whether or not we would be able to disestablish polio immunization, if we followed the example of successful smallpox eradication in the 1980s. It is hoped that the above-mentioned related research would provide a useful orientation in the future. Until then, it would be safest to continue to use OPV. In this connection, the use of inactivated polio vaccine (IPV) has been an issue of discussion in recent years. Currently, in many industrialized nations such as those in North America and Europe, continuing national programs for polio immunization have shifted from OPV to IPV (combined with other vaccines or alone). On rare occasions OPV causes vaccine-associated polio paralysis (VAPP) whereas IPV does not. However, OPV is the WHO-recommended vaccine for polio eradication because of its proven efficacy at stopping polio transmission, ease of oral administration and affordability vis-à-vis the global cooperative effort. Studies are underway on how to use the Sabin strain for IPV production to reduce the risk of use of wild poliovirus, how IPV can be effective, for example, if unexpected wild polio transmission occurred in sub-Saharan Africa, and importantly, how to reduce the cost. At this moment, we should sustain OPV both in production and stockpiles for vaccination until the time when the abovementioned research together with that of VDPVs produce sufficient evidence to make further for judgment.

4. Future strategy

4-1. Estimate of polio transmission in 2009

Our immediate concern is where the polio endgame will stand in 2009 (Figure 1).

South Asia: There are still three endemic nations in this region. The first two, Afghanistan and Pakistan, form one epidemiological unit, defined by the political conflicts across their shared border. Low polio incidence has continued, reflecting the challenges of conducting eradication activities in places having poverty, inaccessible areas and armed conflict. Unless current armed conflicts cease and peace is restored before 2009, it is hard to be optimistic that polio transmission can be stopped there.

The third is India. Endemic polio remains only in the northern states of Uttar Pradesh and Bihar. These states have been largely left out of the active economic development taking place in other parts of India. The continuing transmissions in northern India simply reflect the accumulation of unvaccinated susceptibles due to unsatisfactory program implementations coupled with the extremely densely populated Ganges River area and the unsatisfactory sanitary situation. Type 1 has been the most dominant virus in circulation. In the circumstances, mOPV type 1 and mOPV type 3 have been
employed since 2007, as recommended by WHO based on studies of this strategy (17,18). The strategy now has made substantial reduction of type 1 circulation, but as anticipated, a sudden upsurge of type 3 has been noted. No type 2 circulation has been found in recent years. Currently, selective use of mOPV type 1 and mOPV type 3 is under way as appropriate in selected districts. Whether India reaches zero status in 2009 depends upon the extent of district, state and national prioritization of the polio endgame, because all of India, except for these northern two states, as well as Bangladesh with similar geographical feature to northern India, have been free of endemic polio in recent years.

Thus, in India, there is no technical reason to forecast continued poliovirus transmission in 2009. But if transmission does continue, it is proposed that under International Health Regulation (IHR), those travelling in and out of India must have vaccination certificates according to the new regulation (5). Foreign travellers visiting India also require polio vaccination certificates. These precautions should apply to all other polio reporting nations in 2009. Also, if transmission continues, a special international commission (UN/WHO), newly formed, should visit the States of Uttar Pradesh and Bihar for an in-depth evaluation as to how to interrupt transmission there.

Sub-Saharan Africa: Nigeria is the only polio-endemic African nation, having its main endemic areas in the north. Here the problem has been lack of vaccine delivery. The epidemic curve shows a continuous upward trend from 28 cases in 2000 to 1,122 in 2006, due to widespread refusal of vaccination by communities due to inaccurate judgment of vaccine safety in the early 2000s. The political and religious climate has changed considerably, with lower transmission in 2007. But whether Nigeria reaches zero status before 2009 remains to be seen.

There are also some sub-Saharan nations that still have residual polio transmission (Figure 1). They include Chad, the Democratic Republic of the Congo, Niger and Angola; the first two suffer from political unrest. Continuing transmission caused by importation in the Democratic Republic of the Congo and Chad are of concern. We consider this geographical region to be highly vulnerable, requiring intensified efforts before 2009 if polio is to be eradicated. National programs are becoming exhausted due to the long struggle for the eradication of polio. Matters are worsened by limited resources, which also must cope with fighting other serious diseases, such as AIDS, malaria and tuberculosis. Here, we specifically mention that, of 44 nations in this part of Africa, there are 26 nations with excessively high ratios of U5MR of more than 150. Only three nations appear to have achieved MDG no. 4, the target of child death reduction by two-thirds from 1990 to 2015 (Table 2).

Experience has shown that it is extremely rare to have a distant exportation from Afghanistan and/or Pakistan, whereas the ongoing transmission in both northern Nigeria and northern India has repeatedly resulted in international spread of wild poliovirus. Thus, delays in completing eradication in India and Nigeria have particularly grave consequences.

4.2. Other considerations for a future strategy

While the preceding sections refer mostly to a few negative observations, there are also positive developments: namely, the global acceptance of the MDGs. In 2000, a United Nations (UN) conference established the MDGs aiming at strengthening socioeconomic development and health with a focus on nations with extreme poverty. This was seen as the remedy to ameliorating the ill effects of globalization. Of the eight goals, four are health related, with goal no. 1 dealing with eradication of poverty, and nos. 4, 5 and 6 specifically dealing with health. While the MDGs have started to receive special attention from bilateral and multilateral funding agencies, it would be most desirable to explore the feasibility of explicitly linking the immunization programs specifically with MDG no. 4. This proposed linkage is based on the lessons learned from global polio eradication. Immunization is recognized as one of the most practical and cost-effective public health tools. Here, preventive medicine contrasts sharply with curative medicine, as the latter requires extensive education and training supported by elaborate medical facilities.

Despite the delay and difficulties mentioned in the preceding section, the program did effectively implement a polio immunization system that reduced the number of polio endemic nations from 120 in 1988 to 4 in 2007, evidence that single-disease-targeted efforts could be effective. The delay in polio eradication has kept a large number of polio-free nations in a “holding pattern” for 5 to 10 years, and such circumstances have actually promoted many health officers at the national and regional peripheral levels to intensify the integration of polio eradication efforts with other health measures. These have included the distribution of insecticide-treated bednets (ITN) to protect against malaria, supply of vitamin A supplement to promote health, or the delivery of other vaccines to protect against other vaccine-preventable diseases like measles. In this respect, we are pleased to note activities such as “Reaching Every District” or RED to strengthen routine immunization, especially in sub-Saharan Africa as well as the event of Child Health Days for child survival (19).

These developments suggest that many nations are concerned and keen to initiate an evolution from “mass” polio immunization to “routine” immunization for polio and other diseases. The expected benefits of both the elimination of polio and the control of multiple other infectious diseases are considerable. In fact, in January 2008, the WHO Executive Board was of the opinion that “Vaccine-preventable diseases are responsible for approximately 25% of the 10 million deaths occurring annually among children under 5 year of age.... Vaccines could help significantly reduce infant mortality and contribute to the achievement of the United Nations Millennium Developmental Goal number 4” (20). The scale-

Table 2. Under-five mortality rate (U5MR)-sub-Saharan Nations (2006)

<table>
<thead>
<tr>
<th>U5MR (per 1000 live births)</th>
<th>No. of nations</th>
<th>No. of deaths of children under 5 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 200</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>200-150</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>150-100</td>
<td>15</td>
<td>4.7 million (45%)</td>
</tr>
<tr>
<td>Under 100</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>10.4 million (100%)</td>
<td></td>
</tr>
</tbody>
</table>

1) If China and India are excluded, deaths of children under 5 years of age (in 1,000)
   China: 727
   India: 2,317
   Total: 3,044

2) Japan, Switzerland, etc. U5MR – less than 5

up of measles campaigns over the past 5–10 years has had a tremendous impact on child mortality and is well-proven to merit being a fundamental part of any scale-up of essential interventions (21).

5. Proposal for a new initiative starting in 2009 onward

In the increasingly globalized world, the public health interdependence among all the nations has increased (5). We are entering a new era that, given the complexities of polio, needs a new approach or new initiative linking the existing polio eradication program with MDG no. 4, aiming at a successful integrated initiative for long-term, wide-scale health improvement.

However, experience has shown that effective integration requires careful preparations to succeed. Therefore, in this section, we first describe a practical scenario by which such integration can be developed specifically for sub-Saharan Africa, the very region such integration is most needed. They are described below:

Principal integration requirements

i. A standard vaccine package which contains a combined vaccine of diphtheria-pertussis-tetanus (DTP), hepatitis B and Haemophilus influenzae type b; and trivalent-OPV (for use of IPV, refer to Section 3). They will be bundled with a well-equipped cold chain system. Measles can be added, at a different scheduled visit of the team. Pneumococcal conjugate vaccine and rotavirus vaccine should be added as soon as they are available. Relevant studies are now underway in a few African nations, and the introduction of this package to Africa may be evaluated by WHO in early 2009. Both can contribute considerably to reduction of child death caused by pneumonia and diarrheal diseases.

ii. Auto-disable syringes (AD syringes) will also be bundled with the vaccine package.

iii. Special transport (simple vehicle for four persons) will be designed and supplied to facilitate movement of vaccination teams.

iv. Wherever possible, ITN and vitamin A supplement will be distributed.

Assessment: An officer from the highest level of disease surveillance at the Ministry of Health will independently take responsibility for the assessment activities, with the aim of finding out the number of child deaths and probable causes under the age of 5 in the areas where vaccination has taken place within a 6-month interval.

WHO/UNICEF would set up a joint international team to assist all the negotiations taking place between individual governments and providers. Such teams are assigned at WHO regional offices.

This is the scenario for sub-Saharan Africa. It is hoped that the proposed integration may take place in any nation where MDG no. 4 projects are being delayed. There would be exceptions for the four polio-endemic nations, Afghanistan, Pakistan, India and Nigeria, where polio eradication would be the first priority until 2009. Some of the above four nations have already developed some joint work, for example, a measles vaccination campaign. In this case, we trust national judgement about short-term coordination. However, joint work after 2009 would be more productive.

All these measures also contribute to protecting children from natural disasters caused by the current global warming, with their attendant epidemics of infectious diseases, some of which could certainly be prevented by immunization. Further, the reduction of child deaths may eventually lead to promotion of mothers’ interest in family planning, which is notably neglected in sub-Saharan Africa.

6. Summary and conclusion

A “world of disquiet” seems the best way to describe the characteristics of the 21st century. This is certainly true of the global polio eradication effort initially launched in 1988. At the time, it was expected that polio would be eradicated by 2000. Now, in 2008, although good progress towards the goal has been achieved, endemic and imported polio still remain in sub-Saharan Africa and South Asia. The current situation has been frustrated by lower-than-expected OPV efficacy, migration associated with globalization and continued extensive poverty and political turmoil in these special geographical regions.

We propose measures, building upon the gains of the existing polio eradication program, to add a special campaign to intensify immunization efforts for all vaccine-preventable diseases specifically in sub-Saharan Africa and South Asia. Although vaccines are one of the most cost-effective public health tools, considerable collaboration and funding are required to realize their benefits in these regions. The victims of vaccine-preventable diseases are most frequently infants and children under 5 years of age. Why should children in these areas suffer from the misery of such easily preventable diseases? They are innocent and dependent on all of us for their health. According to “Law of People”, all of mankind is responsible for this misery (22). Its continuation should be declared unacceptable by us all.

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