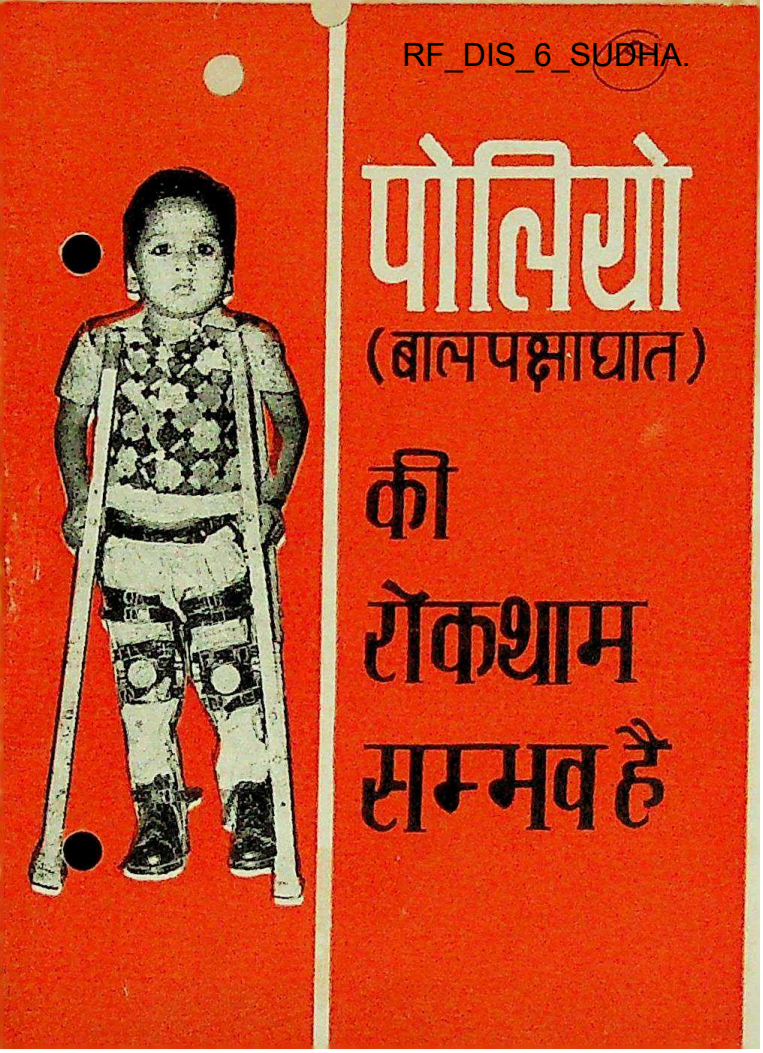


पोलियो
(बालपक्षाघात)
की रोकथाम सम्भव है

पोलियो (बालपक्षाघात) की रोकथाम सम्भव है

पोलियो एक तेज छूत का रोग है। प्रमुख रूप से तीन माह से पांच वर्ष की आयु के बच्चों को यह अधिक होता है। इसका असर केन्द्रीय स्नायुमण्डल पर होता है। इस रोग का कारण एक विषाणु (सूक्ष्म-जीवाणु) है, जिसे 'पोलियो विषाणु' कहते हैं, ये विषाणु नाक और मुंह के द्वारा शरीर में प्रवेश कर आंतों में पहुंचते हैं और वहां रह कर बढ़ते और पनपते हैं। फिर रक्त के साथ मिलकर केन्द्रीय स्नायुमण्डल में पहुंचकर रीढ़ में स्नायु-कोशिकाओं को हानि पहुंचाते हैं, जिससे रोग उत्पन्न हो जाता है। यह स्नायु के लकवे के रूप में प्रगट होता है।

रोग कैसे होता है?

इस रोग की छूत लगने के बाद, रोग के प्रगट होने में औसतन 17 दिन लग जाते हैं। इसकी छूत प्रायः

रोगी के मल-मूत्र से स्वस्थ व्यक्ति तक मुंह के द्वारा शरीर में पहुंचती है। इसकी छूत का माध्यम मनुष्य ही होता है। वैसे तो यह रोग किसी भी ऋतु में हो सकता है, किन्तु ग्रीष्म और वर्षा के बाद यह रोग अधिक होता है।

रोग के लक्षण

रोग के आरम्भ की अवस्था में बच्चे को बुखार-सा (हल्का या तेज) हो सकता है। इसके साथ ही उसे सिर-दर्द, जुकाम, उल्टियां, सुस्ती, पेट में गड़बड़ी, गर्दन या पीठ में अकड़न तथा उसके शरीर पर खसरे जैसे दिदौरे हो सकते हैं। रोग बढ़ जाने पर बच्चे को कब्ज, बेचैनी तथा कुछ मांसपेशियों में कमजोरी या लकवा हो सकता है जिससे वह कुछ अंगों को हिलाने-डुलाने में असमर्थ हो जाता है। यदि मांसपेशियों पर असर हुआ हो तो इस रोग के कारण बच्चे को निगलने या सांस लेने में कठिनाई भी हो सकती है।

निदान और उपचार

अनेक लक्षणों से युक्त रोगी के मल में इस रोग के विषाणु को पहचान कर तथा लसीका में बढ़ते हुए प्रति-पिण्ड देखने से ही निदान हो सकता है।

वैसे तो पोलियो का कोई खास इलाज नहीं है फिर भी तेज संक्रामक रोग में इसकी रोकथाम की सामान्य विधियों का पालन करते हुए रोग से प्रभावित अंगों की काय-चिकित्सा तुरन्त आरम्भ कर देनी चाहिए।

जब यह रोग कहीं महामारी बन गया हो तो उस इलाके के लोगों को सामूहिक रूप से पोलियो निरोधी टीका या पीने की दवाई दी जाए और सामान्य सुरक्षा और स्वच्छता के नियमों का दृढ़ता से पालन कराया जाए।

वैक्सीन लीजिये--पोलियो से बचिये

पोलियो से बचाव का एकमात्र उपाय पौलियो वैक्सीन है। मुंह के द्वारा सेवन किया जाने वाला वैक्सीन (पोलियो वैक्सीन) इसके प्रतिरोध के लिए सबसे ज्यादा महत्वपूर्ण है। किन्तु याद रखिये रोग हो जाने के बाद यह रोग को ठीक करने में कारगर नहीं है। यह टीका तीन माह की अवस्था के बच्चे से लेकर बड़ी अवस्था तक के सभी व्यक्तियों को दिया जा सकता है। इसकी तीन खुराक 4-6 सप्ताह के अन्तर से देनी चाहिए। सर्दी के दिनों में इस वैक्सीन को सेवन करना अच्छा रहता है, क्योंकि गर्मी में अतिसार या पेचिश आदि के कारण इसके असर में गड़बड़ी हो सकती है।

शिशु को टीका देने के 1 घंटा पहले और 1 घंटे बाद तक स्तन-पान नहीं कराना चाहिए। जिन व्यक्तियों ने टीका लिया हो उन्हें टीका लेने के आधा घन्टा बाद तक गर्म जल, गर्म दूध या गर्म काफी का सेवन नहीं करना चाहिए।

अन्य तीव्र संक्रामक रोगों, तेज बुखार, पेचिश, ल्यूकेमिआ (रक्त में श्वेत कणिकाओं की अधिकता) में तथा 'कार्टीकास्टेराइड' एवं कैंसर-निरोधी औषधियों के सेवन करते हुए यह वैक्सीन नहीं देना चाहिए। जिस दिन पोलियो के वैक्सीन का सेवन कराया जाए उस दिन उस व्यक्ति को कोई अन्य प्रतिरोधी टीका भी नहीं लेना चाहिए।

रोकथाम के अन्य उपाय

वैक्सीन के अतिरिक्त इस रोग की रोकथाम के लिए निम्न उपायों का पालन करना भी जरूरी है :

1. खान पान को धूल और मक्खियों से बचाकर रखें। कच्चें खाये जाने वाले फलों और सब्जियों को खाने से पहले शुद्ध जल में अच्छी तरह धो लें।

2. बच्चों को पहले से कट रखे फल तथा धूल, मक्खियों से दूषित खाद्य-पदार्थों का सेवन न करने दें ।

3. पीने के लिए नल का सुरक्षित जल ही प्रयोग करें हैंडपम्प या कुंए-तालाब का पानी यदि पीना हो तो उबाल लें । दूध को भी पीने से पहले उबालना जरूरी है ।

4. बच्चों को ऐसे पानी में न खेलने दें जिसमें कूड़ा-करकट या गन्दी नाली का पानी मिला हो ।

5. यदि आसपास पोलियो हो रहा हो तो ऐसे समय में बच्चे के टांसिल्स का आपरेशन न करायें, अपने डाक्टर से सलाह करें ।

6. यदि सम्भव हो तो स्वच्छ और सुरक्षित शौचालय में ही शौच के लिए जायें अन्यथा पाखाने को अच्छी तरह ढक दें या दबा दें ।

7. जब पोलियो किसी इलाके में महामारी बन गया हो तो अपने-अपने बच्चों को अधिक सर्दी और परेशानी से बचायें ।

8. आसपास पोलियो के मामले होने पर बच्चों को पोलियो के रोगियों और भीड़-भाड़ से दूर रखें ।

सावधान

- उपरोक्त लक्षणों में से यदि मामूली से लक्षण भी आपको अपने बच्चे में दिखाई पड़े, विशषकर गर्मी और बरसात के बाद, जबकि पोलियो रोग अधिक हो सकता है, तो सावधान हो जायें और ऐसे बच्चे को बिस्तर में पूरी तरह आराम करने दें।

- पोलियो के मामले होने पर अपने बच्चे में उससे सम्बन्धित साधारण से लक्षण देखते ही तुरन्त डाक्टर की सलाह लें।

- ऐसे में अपने बच्चों को रोगी बच्चों और भीड़-भाड़ से अलग रखें और उन्हें यह भी समझा दें कि वे अपना रूमाल, तोलिया, खाने-पीने के बर्तन या पहनने के कपड़े आदि किसी और को इस्तेमाल न करने दें।

- यदि आपके घर में किसी को यह रोग हो गया हो तो रोगी को तुरन्त ही किसी एकान्त स्थान में रखें। इसके साथ ही जिन-जिन बच्चों को टीका नहीं दिया गया है उन्हें टीका दिलवा दें और उन्हें रोगी बच्चों के साथ कम से कम दो सप्ताह तक न मिलने दें।

- रोगी के मल-मूत्र, थूक, छींक, आदि को सुरक्षित ढंग से जलाकर नष्ट कर दें ।
- रोगी की सूचना अपने निकट क स्वास्थय केन्द्र या स्वास्थ्य कर्मचारी को तुरन्त ही दे दें ।

केन्द्रीय स्वास्थ्य शिक्षा ब्यूरो, स्वास्थ्य सेवाओं का महानिदेशालय, कोटला मार्ग, नई दिल्ली-110001 द्वारा प्रकाशित तथा प्रबन्धक, भारत सरकार मुद्राणालय, नोलोखेड़ी द्वारा मुद्रित ।

MGIPNLK—17/DGHS/74—21-3-75—10,000 Copies.

CHRISTIAN MEDICAL COLLEGE AND HOSPITAL
DEPARTMENT OF VIROLOGY AND IMMUNOLOGY
VELLORE TAMILNADU 632 004 INDIA

T. JACOB JOHN, FAAP, FRCP(E), Ph. D, Professor
MERCY JOHN, MD, Lecturer (Microbiology)
VINOHAR BALRAJ, MD, Lecturer (Community Health)
THOMAS CHERIAN, MD, DCH, Lecturer (Child Health)
P. GEORGE BABU, Ph. D, Research Associate (Immunology)

Telephone : 0416 - 25035
0416 - 22102 (Ext. 70)
Telegram : MISSIONHOS VIROLOGY
Telex : 405 202 CMCH IN

Ref:P-5.a

30 June 1988

Dr.Prabir K Chatterjee
Associate Director
Centre for Rural Health & Social Education
A-11, Ashok Nagar, Tirupattur 635 601.

Dear Prabir,

This is in reply to your letter dated 23.6.88. Dr.John is in Moscow. What I have written here are my views and not necessarily Dr.John's.

1. The vaccines referred to in your letter left the factory with a 6 month expiry, lay in cold storage at Madras until potency tests were done by the national vaccine potency testing facility at Himachal Pradesh. It was then in circulation for 3 months before expiry. We have been storing it at -20°C and supplying it for 3 months.

2. I do not know if any company stocks outdated vaccine or supplies it free.

3. I do not have details about what CHAD used in May-June of 1988. You will have to ask them.

4. ICMR finances the North Arcot District Polio Control Program in collaboration with Govt.of Tamilnadu. About 18 lakhs is being spent. None of it is meant for vaccine delivery. Refer MADHI Vol 3, No.6 (June 1987) for objectives of the study.

5. We do not insist you get informed consent of the parents. If you wish to do do, we have no objection.

6. I do not understand question 6

7. Question 7 is frivolous what do you think? The OPV you received is not the study vaccine. The study vaccine is a killed polio vaccine that is being currently used in the Tiruvannamalai Health Unit District. It's expiry is sometime in 1989.

The vaccine you got was a gift from Rotary International. They intend to supply Tamilnadu's entire OPV requirement for 5 years and this was the first batch intended to flush out the system and get everybody ready for a OPV glut in the state. The next consignment will come in early August with a longer expiry and we will continue our free supply of the vaccine from this stock.

You have asked for forgiveness for asking questions. Some of your questions are frivolous but I forgive you. A little education regarding live viral vaccines will do you no harm.

The live viral vaccines go into a 'suspended animation' at -20°C Their shelf life hence gets prolonged by the period it stayed at -20°C. If stored at +4 to +8°C, it would reach the end of its shelf life and potency by the time its date of expiry approaches.

Outdated OPV will cause no harm if it is potent. It may not be any good/have a vaccine with an expiry 2 years hence, but of lousy potency at the time of use. There is hence no magic in expiry dates stamped on vials. Generally speaking, you do not use outdated vaccine but if you know its good, you are a fool to throw it away. /if you

If you ~~have~~ gave me an option of using an outdated OPV of good potency for my child versus no vaccine, I would take the outdated vaccine. If I was not very educated and my child developed chicken pox after receiving a dose of OPV which my doctor said was of dubious quality, I would then scream murder at the doctor who gave it.

I have tried to make you understand the issues involved. If you feel uncomfortable, stop using the vaccine. When the next batch comes in August I will let you know.

Regards

Yours sincerely,

Dr.Vinohar Balraj
Project Officer
North Arcot District
Polio Control Program

VB/ns

Dear Ravi & Helen.

Have not heard from you since we visited to Bangalore.

Collaborationism of PPST is trying to get the Indology Mission to liberalise the cycle of indigenous system in the Immunisation Programme. At least a place in the development of general immunity & (a) the treatment of polio cases.

Sivaram has sent me a "Frontline" article dated January 10-23, 1987 (Pg. 100-101). It is a reprint from a Science 86" article by Daniel Jack Chasan et deals with the Polio Vaccine controversy (i.e. IPV vs. OPV)

VJN
21/7/88

There is another chance connection in this article. Apparently after Salk's vaccine was discredited or at least stopped from use in most countries, only one laboratory manufacturer CONNAUGHT LABORATORIES of Canada continued to make Salk vaccine throughout the 1960s.

Well, CONNAUGHT LABORATORIES' Measles Vaccines are the ones that are being supplied free in North Africa, courtesy UNICEF Centre de Vaccins/CMC.

So there any way to find out whether there are any other manufacturers of Measles Vaccine in Canada (2) why the Canadian Rotary has been especially interested in Pakistan vaccination programmes in the past?

Not the U.S. Patent or the British or even the Indian? Where else is Measles Vaccine produced?

Apparently the acceptance of the Institut Merieux (France) IPV depended on a 1986-7 study of the comparative effectiveness of it & OPV.

Have these studies been done & has an FDA license been given?

Or is that testing being done in North Korea?

Prof.

CRHSE
A-11 Ashok Nagar
Tirupattur-635601
30/6/88

Dear Helen & Ravi (& Lalit),

How are you?

We have just received a batch of expiry-dated vaccines from Delhi. Though the ICMR Centre of Virology at CMCH says that they will work for another 2 months we are quite unhappy & we dislike expecting them.

Contacted Dr Kelkar regarding this.

The English version of the replies from 9 professors & medical teachers on controversial drugs is ready. You'll get a copy soon. (It's also in our Annual Report 1987).

The Training Coordinator at RUHSA - Mr. Saminathan - is going

to be CRHSE's next Director. He'll start work here next week & take over in September when Bennet leaves for Nagpur to become one of the National Council of Churches' Secretaries at Nagpur.

Suppose the meeting at RUHSA will be from 4th to 6th July and I shall be coming to RUHSA campus on 5th July (TUESDAY) evening to meet Ravi.

Love.

130

medico friend circle bulletin

JULY 1987

Paralytic Poliomyelitis : A Tragedy on the Rise

Gloria Burrett

The Spastic Society of Northern India is a voluntary organisation which runs the Centre for Special Education. This is a special school for children with cerebral palsy. Here problems such as stubborn self willed limbs, specific learning difficulties, hearing problems and unintelligible speech are handled by a group of professionals working closely with the parents of the affected children. This article traces our increasing intervention in the area of polio, both in management and prevention. This is significant in that, cerebral palsy was intended to be our main area of specialisation. We also hope to project through this the enormity of the problem in that—epidemics of polio are occurring in an area well connected to hospitals; despite the OPV (oral polio vaccine) children are being affected by polio; and general practitioners are aggravating the problem by the indiscriminate use of injections.

Our rural centre:

Two years after starting our centre at Delhi and following our brief experiment with the children from Madangir (an urban slum development area of Delhi), we felt it was necessary to reach out to the many children affected by cerebral palsy in the villages. Our centre would have to be sufficiently distant from Delhi for it to be viewed as a necessity and yet close enough for our regular visits. This October will have made it six years since the inception of our rural centre at Dayalpur village (Faridabad District). The centre is situated within the Primary Health Centre campus, 10 kms from the district hospital at Ballabgarh which is also the training centre for interns from the All India Institute of Medical Sciences, and approximately 20 Kms from the main civil hospital at Faridabad. One could say that the area we chose had access to primary health care as well to other referral services.

Soon after the rural centre was opened, we realised that there were several problems in starting a centre of this kind in villages. The whole area of "handicap" is not a priority. Children with severe cerebral palsy die or are starved to death. In poorer families like those of the daily wage earners where the work load on parents is greater, each day's wage is precious; and where it is difficult to feed one's normal children, the handicapped child is a problem that is best forgotten. So, often we had to create a problem in the minds of parents and make the child's handicap appear more serious than it seemed to them at that time. In our minds we could imagine these disabled children growing into handicapped adults.

Shift of Priorities:

Of the seven students we started with, only one, a severely handicapped, immobile, intelligent, eight year old with cerebral palsy was brought in by parents who were desperate for our services. The others we admitted were either mildly affected physically and/or had speech problems. One was a child with polio whom we wanted to integrate into a normal school as quickly as possible. There was always the feeling that with our limited staff and our initial intention of rehabilitating children with cerebral palsy, the condition of polio could never take precedence. We believed that the severely affected spastic children in the course of time would make up our numbers and take up our full attention.

However, within six months, and increasingly so today, the great number of polio referrals and to a lesser extent those with hearing problems have made us think otherwise. The following facts are indicative of our growing involvement with polio.

Today the breakup of our children is as follows:

Polio	—52
Hard of hearing	—24
Cerebral palsy	—17
Others	—13

These figures are not a complete index of cases existing in this area, but only those who attend our centre. There are many mildly affected polio cases who see no need for our services and some severely affected cerebral palsy children who are unable to attend our centre. But we are aware that the number of polio children who are not being catered to by the centre at present far exceeds the latter.

To cater to the growing number of cases other than cerebral palsy, a home management programme was introduced for children needing specific help in one or two areas and needing to attend the centre only once a week, fortnight or a month. We held a six-months training course for local men and women to enable them to detect, diagnose and treat polio. Right now there are six fully trained rural rehabilitators who are instrumental in increasing the number of polio referrals. Their closeness with the community aids detection. They also have a special ability to motivate parents as three of them have children affected by polio.

Our medical follow-ups include regulation of drug doses for epilepsy, diagnosis of neurological conditions, audiograms, applying for free aids available in hospitals and operations. Of these, the most running around is involved in the case of operations. Upto five visits are necessary before a child is admitted and another four during admission to get feed-back from doctors. Of the 25 cases we have referred so far, 23 are cases of polio. Following surgery, and also in most polio cases not requiring surgery, calipers and crutches are essential. This requires another round of hospital visits, to ensure that the recommendations we forward are heeded by the doctors. Getting into the area of polio sometimes forces from us a greater involvement by way of time, energy and manpower than we had bargained for and yet there is no choice for us.

What would happen if we referred all such cases to the nearest hospital? The Civil Hospital at Faridabad has two orthopaedic surgeons but our operation cases were turned away with the statement that "this operation is not done here". The District hospital at Ballabgarh does not have an orthopaedic consultant. Four years ago, during an ICMR project on polio, a team from the Rehabilitation department of the All India Institute of Medical Sciences visited the hospital regularly twice a week. Since then all cases requiring rehabilitation are referred to Delhi where the department provides us maximum support by way of diagnosis and provision of aids. A word about the ICMR project is in order here as an example of Government's intervention in the area of polio. The project covered the greater part of Faridabad district. The ICMR team conducted an impressive survey of the number of handicapped children of all categories in all the villages. Measurements for calipers for all polio children were taken at one go and the families were promised delivery of free calipers at their homes. Although some children did receive the calipers immediately, we know that these were still being delivered as much as two years later. Apart from the obvious outcome of ill-fitting calipers and disappointed parents, even those with well-fitting calipers discarded them in a couple of months due to a lack of follow-up. Many homes in the ICMR project area display calipers hung up on the walls as an 'object de art'!

Coming back to the question of referral services for the handicapped children, the chances are that they would be sent onto the hospitals in Delhi of which, Kalavati Saran Children's hospital, the All India Institute of Medical Sciences, and the Safdarjung hospitals are the most frequented. Generally in these hospitals, even if they boast of superspecialities, the rehabilitation units tell a sad tale. I recollect how an intelligent and a very confident parent of one of our polio children had to intervene in his son's treatment. He realised that the fixed contracture would need more than the wax treatment his son was being given. The Consultant was, fortunately, honest enough to admit the misktake—a costly one for the father, who had to travel the long distance from Haryana to Delhi, but the father was allowed to meet the consultant only on his third try when accompanied by me. We also have had parents tell how

futile they felt the daily sessions to be and even after a year of treatment at one of these hospitals many parents have no real knowledge of the problem. Over 50% of our cases are drop-outs from such hospitals because of the problems of distance, time and money, They now have children needing operations for unattended fixed joints because of parental frustration in the face of the uncaring medical profession.

All this has forced us to get into this area of polio in greater depth. We have had to follow-up old hospital cases, accompany parents to hospitals, be actively involved at every stage of the operation procedure, and motivate parents and children into doing therapy so that mobility and integration may follow.

This management of polio has made a difference in that it has helped us gain more credibility. While earlier, a high percentage of acute cases relied on the local village 'phalwan', who claim to have the ability to activate flail limbs through vigorous massage (even within the very vulnerable first month following the onset of polio), today, we are being referred acute cases as compared to the initial referral pattern of cases of plus-five years of duration.

From Rehabilitation to Prevention

The next step was apparently to go beyond the acute cases and evolve measures to prevent or lessen the incidence of polio. However, after giving it much thought, we felt ill-equipped to get involved with such measures. It would have meant involving ourselves with too many priority problems, a situation where we would be spreading ourselves too thin. We already had on our priority list the following priority areas: training courses, sheltered workshop, employment opportunities in factories, educational programming, integration, daily management of cases, following-up government facilities for the handicapped and completing the medical follow-up. But two issues forced us into the area of prevention sooner than we thought. The first was a recent case of polio following an injection administered by a private practitioner for low grade fever. The second an epidemic of six cases of polio at Madalpur village. This epidemic would have gone unnoticed save for the referral by a Physical Training instructor in the regular school who had been approached by parents to strengthen their daughter's lifeless limbs (she had been a normal two years old till two days before the paralysis). Since then an isolated case of six-days onset was detected by us in Tigaon. In all 10 acute cases were enrolled in the month of April 1987.

There were three disturbing facts about this epidemic. (1) A recent survey carried out by the Dayalpur primary health centre showed that out of the 36 cases who had received three doses of OPV, 18 had contacted polio; (2) why with two hospitals within half an hour away, should there be such an epidemic? Both these hospitals run primary health centres attached to them, and immunisation is meant to be a priority area for the staff; (3) It is a known fact that 90% of the polio cases follow injections given during the early symptomatic stage of fever/cold. Why then were the doctors indiscriminately using injections for fever cases in children? The urgency of the situation however, demanded that we take immediate action. Our action included working at four levels:

1. *Private doctors*— A meeting was held where all the private doctors from the nearby villages were invited to find out their routine 'treatment' of polio as well as their awareness to the link between intra-muscular injections and polio. The meeting was most revealing in that none of the doctors present knew that an IM injection could aggravate paralysis. They felt that as long as there was no reaction to the injection and as long as it was properly given, no problem could result. They surmised that only when the child was injected wrongly, 'injection palsy' could result, and the fault therefore lay with the technique and not with the practice.

We did manage to convince them of otherwise with our practical experience, medical data, and explanations. They were also made aware of our seriousness in following up each such case with the doctor concerned. Even those who did not attend our meeting were sent a summary of the proceedings. Appreciating the doctor's problem of giving into persistent parents to whom an injection is a magic remedy, we arrived at the following compromise. The doctors could continue using injections as before except in children under five years of age suffering from fever and chills and especially during the months of May to September. As a follow-up to our meeting, a private doctor ready to inject a child put the syringe away and persuaded the mother to rely on tablets, on sighting two of our staff who chose that moment to call on him!

2. *Affected Families*— A day after hearing about the epidemic, our local team went round Madalpur with their charts and songs on polio. As people who had gone through similar experiences, the members of the team supported and advised the parents of the affected children. Stress was placed on 'what not to do' in the first month following the attack. A report was lodged with the Sarpanch, and details regarding our centre was left with the parents. A month later as none of them had visited us, another visit was made to explain the change in treatment and to look into the matter.

3. *Community*— An all out effort was made to inform all our old and new parents as well as their neighbours about the epidemic, the need for immunization and the role of injections. Many who had not been given the OPV in Tigaon were referred immediately to Ballabgarh hospital.

4. *Government Health Authorities*— Madalpur village is under the jurisdiction of the Chief Medical Officer, BK Hospital, Faridabad. Through a letter personally delivered to him, we appraised him of the situation and the need for follow-up action. We also offered our help. However, there was further feed back only when our local team made a second visit to the area a month later and found out that children had been given their first round of OPV. Following the CMO's delay in getting back to us, we approached a doctor at Ballabgarh district hospital who felt that it was not possible for one government organisation to interfere with the area that lies within the jurisdiction of another government organisation. He also felt that we, as a voluntary organisation, should not have delayed in buying vaccines and administering them in the village when we came to know of the epidemic. It was obvious that the problem was back in our court. But the question remains as to why a voluntary organisation be asked to take on a major responsibility when there were well-equipped and well-staffed government hospitals that were supposed to provide comprehensive health care to the population it covered. We still have to meet the CMO, the Health Workers, and Supervisors at the two sub-centres (Madalpur and Tigaon) to find out details pertaining to the immunisation programme.

There is no way of knowing how effective all this will be. Our credibility in this area has certainly

(*Contd. on p. 7*)

Dear Friend,

Inspite of being one of the 'cowards' myself I share the basic point that the Gadres have made in their article 'When Rome is Burning' (mfcb-124). In fact it is from the point of view of community health itself, defined in its broadest and most political sense, that I see the need for more attempts at and experiments in clinical medical practice. The process of evolving an alternative health system(s) has to include alternative ways of clinical practice. Community health theory has to include an analysis of existing clinical practice (which it has to a large extent) as well as evolve a system of curative health activity conducive to our notion of an egalitarian, human, health system. But any theory evolving in a vaccum is meaningless. Theory and practice together can be the only way of working out any socially meaningful alternative.

Of course, clinical practice alone has its limitations. But don't community health activities alone have their own limitations as well? Curative medicine always ends up forming an important part of any such programme and most of us fall back upon the conventional form of clinical practice. However, our major impact in terms of the message carried to the people is often through the curative services rendered because they are the ones felt to be the most needed and relevant by the 'people' themselves. It is the most important contact point and a major need. But as yet, I feel, that we have failed to evolve modes of clinical practice in accordance with our understanding of the existing and of the desirable health system: the doctor-patient relationship, technology to be used, the approach towards 'treatment' and 'healing', the holistic vs partial view of a patient/person, the balance to be struck between treatment as human intervention and allowing nature to do its own work in the healing process etc. etc... Not that all these issues have been theoretically resolved as yet but neither can they be without trying out various options in practice and testing their validity in the social reality rather than as we think it to be.

All I'm trying to point out is that it isn't a question of clinical practice vs, community health work. They are both a part of and complementary to each other. Both are socially relevant from a radical progressive view point if undertaken with certain

value positions and with attempts at fresh thinking and innovative action in response to the social reality around us. One can understand the reaction of the 'community health wallas' to curative medicine because of the overriding emphasis on it with neglect of the social aspects and because of the nature of curative medicine in the established health system. Unfortunately it has also resulted in our acquiring a 'holier than thou' attitude bordering on the contemptuous towards clinical practitioners, even those trying to practice honestly, ethically and creatively. This is what the Gadres are reacting against, and therefore the extreme positions and strong language that they have used.

And this kind of clinical practice is in many ways a much more difficult task than that of keeping one's hands clean and staying out, engaging either in safe, 'clean' work such as a community health project doing preventive, educative and social activities or engaging in 'research'. To be able to hold one's own and work amidst others who are corrupt, within a system which can easily eliminate, amidst a clientele which demands a certain kind of services which it has been habituated/addicted to is an extremely intimidating task, full of frustration, helplessness and the fear of getting carried along with the tide. It requires much greater strength of conviction and an inner strength to be able to hold out. It also requires the ability to innovate and creatively use available resources in accordance with one's critique of prevalent medicine and clinical practice. Mutual support and exchange of experiences could be most helpful in such a situation.

Therefore if we see the two (clinical practice and community health work) as parts of a whole I would consider it important to support and encourage clinical practice of the kind referred to. I wonder if mfc can become, besides a group of doctors and others focussing on community health, also a forum for discussion and debate on ethical, innovative clinical practice. The mfc bulletin can probably be used to initiate the dialogue among such clinical practitioners and between them and those focussing on community health. Later a separate cell could be made for this if the need arises making the mfc, as I see it, more 'wholistic'. Or may be a separate organisation becomes necessary, but that is yet far in the future.

Ritu Priya, New Delhi

The debate on 'medical care vs community health', which started with the Gadres' high pitched cry of "Down with Community Health" has reached a stage when, all parties concerned, need to pause and clarify a number of issues. First, neither Gadres nor Kamla Jayarao, Uplekar——and now Das, have clarified what they mean by the term 'Community Health'. Though, Kamla Jayarao has given us some glimpses of what she has in mind by implication, she has still responded only tangentially to Gadres' attack on community health.

Gadres' main complaint is (1) it is almost 'criminal' for doctors trained to deliver medical care to go into community health; (2) such a 'capitulation' is indeed glorified by the health establishment including the funding agencies. What we are not told very clearly is, whether they are against community health as such or, against community health by *doctors* alone. Das has now joined this debate by enlightening the "elitist and snob sections of the health activists" that the slogan "prevention is better than cure is no longer an in-thing in fashion" and also that "to a moribund patient .. community health carries no meaning except ridicule."

Gadres seem to have completely misunderstood what community health really is and therefore their attack is, in fact, a 'non-attack', attacking what at present goes in the name of community health (with some notable exceptions though). Das, too, confuses the issue further by flocking together community health with other equally unclear terms like self-help.

Therefore, let me try to clarify what, according to me, is meant by community health.

"Community Health is .... a way of looking at the problem of dealing with *ill health in individuals in their social, biological, and physical setting*. Community Health has at its focus *both individual and environment*. Community Health is .... about the health of all the individuals in the community". (emphasis mine) (1). The specific tool of Community Health approach is Epidemiology besides the conventional tool of clinical medicine.

Community Health is about asking the question 'why did this child suffer from pneumonia in the first place' after treating the moribund child with bronchopneumonia following measles—a

child whom Das is so anxious to save. Further it is about asking the question—why do so many children suffer and/or die from pneumonia following measles in the locality where a doctor practices. It is also about asking the question 'why does tuberculosis *persist in the community despite* 20 years of the National Tuberculosis Control Programme and with extremely potent anti-tubercular drugs like Rifampicin available. In no way does it preclude treating an individual suffering from tuberculosis but it certainly prevents a doctor getting the wrong idea that by modern, medical care *alone*,—and thus by modern medical doctors *alone*, tuberculosis can be controlled. Community health approach by placing the illness that presents itself at the clinic—which is often the tail end of the disease process—in the community, it places medical intervention in its proper place: amongst many other types of interventions namely, socio-economic, political and cultural, all of which are needed to do away with a disease.

Secondly, contrary to what the Gadres and Das seem to imply, community health is not (and should not be) a separate discipline. Though a doctor can (and should) obtain special skills in epidemiology, there need not be community health doctors as there need be surgeons, physicians, and gynaecologists. It is possible and it is imperative to impart a community health orientation to clinical medicine. For instance, a doctor who is able to see that a TB patient is unable to come to a District TB Centre for his/her daily stretptomycin injections because it is 10Kms from his/her village and s/he is too poor to afford the bus fare, has the community health perspective. Or a doctor who perceives a pattern in several patients of infective hepatitis coming to his/her clinic from a particular locality and demands that the water supply of the locality be tested is practicing community health. Today, an epidemiological outlook in clinical practice is becoming all the more important to a clinician because of the appearance of iatrogenic diseases. Side effects and toxic manifestations of a a drug do not become obvious unless the treating doctor carefully *looks* for unusual symptoms in a *number* of patients consuming the drug in question. Forming of even such impressions on the basis of observation is community health, in the broadest sense of the term.

Finally, Das' attempt, to defend the existing status of medical practice by absolutizing an important but only one of its aspects namely, the "much needed life saving medicare" is nothing but an exercise in ideological rationalisation of the profit-oriented, often irrational and incompetent, as well as the over-glorified practices in clinical medicine. Does he really believe that the thousands of doctors who flock every city/town in the country are really busy saving people's lives, all or even most of the time? What about cough and cold practice, and un-necessary medications, injections as well as surgery? What about cut-practice? What about the activities favouring pharmaceutical companies wittingly or unwittingly? Or should we not diagnose and treat the deep rooted disease that afflicts the 'noble' profession because everybody else is also suffering from the same disease? Like the omnipresent 'foreign hand', Das invokes the ruling class's attempt to push forward indigenous medicine and self-help and its attempt to denigrate modern medicine in order to, 'destabilize' it. There is some truth in this theory, no doubt. But is it not also true that it is the very nature of modern medical practice at present that has provided the ruling class the ground for crticising it and utilising the criticism to deny modern medicine to the people?

Dhruv Mankad, Nipani

References

1. Ashvin Patel and Anil Patel; "A note on teaching of community health—A Critique"; Background paper presented at the X Annual Meet of MFC, 1983.

* * * *

I have only one question to ask the author of "use and Abuse of Biomedical technology" (mfcb No 124). You, a socially Sensitive doctor, are in the Out Patient Department, and a woman, with tears in her eyes, comes with the request for a sex determination test. She is being terribly ill-treated and is being beaten up every day by her husband and her husband's family. Does one give her a lecture on medical ethics and the declining sex ratio and send her back to be illtreated (and who knows, perhaps to be murdered), or does one respond to her need?

Prashant, New Delhi

(*Contd. from p. 8*)

protecting the individual immunized child, is probably creating a condition conducive to the increase of paralytic poliomyelitis in the community due to its partial coverage. This is the first area of concern.

A study was carried out in Pune in 1983 in which 90% of the eligible population in the slums were immunized against polio with 3 doses of OPV (3). The number of patients admitted in the paediatric ward from 1979 to 1984 showed a sudden increase in the number of cases from 44 in 1983 to 84 in 1984. It was found that 35% of the affected children had infact received three doses of OPV and the vaccines had maintained their potency as observed by random checks. The study concluded that in order to control polio, 100% *coverage of children below one year is absolutely vital and the dosage of OPV should increase from* 3 *to* 5.

Both the UIP and EPI recommend only three doses of OPV, and if indeed the three doses provide inadequate coverage, it will not only aggravate the situation by incresing incidence of paralysis but more important, it will discourage parents from getting their children immunized against polio. This is the second area of concern.

It has been well documented that intramuscular injections predispose children to paralysis if later they are exposed to poliomyelitis virus. Injections which cause an inflammatory reaction can increase the risk of paralytic poliomyelitis upto 25 times. The most sensitive period is in the initial stage when the child develops fever and the first thing that the general practitioner would do in such a case is probably to give an intramuscular injection thereby precipitating paralysis. The educational programmes organized by UNICEF especially through the television concentrate on the need for vaccinations but does not mention other preventive measures that need to be taken into consideration. This is the third area of concern.

It is possible that with EPI & UIP, all these factors have led to a proportionate increase in the incidence of poliomyelitis in rural areas also. But, as the article printed in this issue points out, even if there is an epidemic right under the collective noses of UNICEF, WHO, and the Ministry of Health and Family Welfare (the Head Offices of which are in Delhi), the chances are that it will go largely unnoticed and by the time it does get noticed it could very well be too late.

Sathyamala

References

1. Jacob John, "How shall we control poliomyelitis in India?", Indian Journal of Paediatrics, 48 : 565-568, 1981.
2. R N Basu, "Measles Vaccine, feasibility, efficacy and complication rates in a multicentric study", Indian Journal of Pediatrics, 51 : 139-143, 1984.
3. M P Phadke et al, "Poliomyelitis in Pune vis a vis Immunization in urban slums", Indian Pediatrics, 23 : 5, 351-354.

CHOPAM-II

CHAI announces the second 4-week course on Community Health Organisation, Planning and Management for middle level workers with decision making powers in their programme. The medium of instruction will be English and the venue will be announced later. The training period will extend from 15th November to 15th December 1987.

For prospectus and application forms contact: Programme Director, Community Health Department, Catholic Hospital Association of India, PB No. 2126, Secunderabad 500 003, A P.

(*Contd. from p. 4*)

gone up. Following repeated requests from the parents of polio children and the village leaders, a new centre has been opened at Tigaon. A recent survey done by the local society (Jan Kalyan Samiti) gave us the names of 50 polio children. This did not include the 8 already being treated by us, and those detected more recently. It is interesting to note that the list has 3 deaf children and one child with cerebral palsy. It does seem that we will have to change our priority from providing services for spastic children to helping children handicapped with polio. It is not so much the change in priority that is causing us concern, as much as the question—When the simple technology of immunization is available why should a situation of increasing incidence of paralytic poliomyelitis come up? Could this tragedy not have been averted?

R.N. 27565/76

From the Editor's Desk

According to UNICEF, WHO, and the Ministry of Health and Family Welfare, India is on the verge of controlling poliomyelitis by the year 1990. The Universal Immunization Programme (UIP) launched in 1985, envisages coverage of the 420 districts in India in a phased manner so that by 1990, the incidence of residual polio paralysis will be reduced to less than 5/100,000 population. The strategy of UIP, at least on paper, is better than the EPI (Expanded Programme of Immunization) but three aspects in relation to the control of poliomyelitis through the administration of OPV (oral polio vaccine) raises concern.

It has been observed in the last few years that there has been a paradoxical increase in the incidence of polio in areas where a large amount of polio vaccine is being administered annually. For instance in Bombay, coverage with polio vaccine was found in 37% of school children in std IV, 46% in std III, 47% in std II, and 54% in std I. Contrary to expectations, the incidence of paralytic polio has been steadily increasing in Bombay. A similar situation has been reported from Delhi, Ahmedabad, Madras, Trivandrum, all of which are urban centres. One explanation has been put forward by Dr Jacob John of the Virology Unit, Christian Medical College Hospital Vellore, to understand *why partial coverage with OPV not only fails to cause a proportionate reduction in incidence but also apparently results in increasing incidence of paralytic poliomyelitis* (1).

Generally, only a small proportion of infants and children infected with polio virus develop paralytic illness. Susceptibility to paralysis is determined by genetic disposition, age at infection, and immune status; a fourth factor is iatrogenic, namely intramuscular injections. Of these it is unlikely that the proportion of genetically predisposed children is increasing, and the current increase in the incidence of polio cannot be because of increasing proportion of children getting infected due to decreased immunity.

Susceptibility to paralysis increases with increasing age at first infection. Infection when the infant is very young, with immunity passively acquired through maternal antibodies, does not cause paralysis. Therefore in un-immunized communities, intensive polio virus circulation is advantageous since infection would occur early. In the passively immune, infection will induce active immunity without the risk of the disease. In others, as age is low, infection is attended by low risk of paralysis. Thus in these communities, the incidence of paralysis would necessarily be low. The increasing incidence in the *partially* immunized communities could be due to the passively immune infants escaping infection only to become susceptible to the risk of paralysis outside the umbrella of protection afforded by the maternal antibody. The age at first infection may also be rising, although subtly, resulting in increased incidence in older children thus increasing the chances of paralysis. Finally, there may be an increase in the frequency of intra-muscular infections which coincident with infection may provoke paralysis. The first two situation are the result of the retardation in the circulation of polio viruses in the community and at the same time the presence of a large proportion of susceptible population. The two factors responsible for the retardation of the circulation of polio viruses in the community are: improvement of hygiene and partial sporadic immunization coverage as immune individuals would be poor transmitters of the virus.

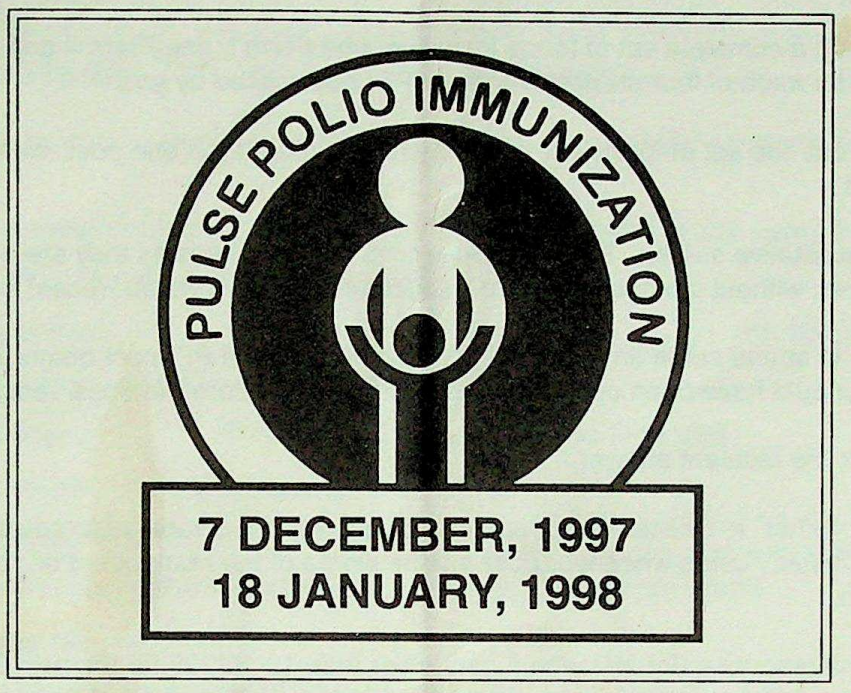
In 1985-86 the OPV coverage in India was 65% in the UIP districts and barely 27% in the EIP areas. It has been reported that there is a high drop-out rate between the first and second dose (43.9%) and second and third dose (39.9%) of OPV (2). The effective coverage is probably even lower because of the enormous difficulties in maintaing the cold chain especially in the rural areas. Thus the UIP programme, while perhaps,

(*Contd. on p. 7*)

Views and opinions expressed in the bulletin are those of the authors and not necessarily of the organization.
Annual Subscription — Inland Rs. 15.00
Foreign: Sea Mail US $ 4 for all countries
Air Mail: Asia — US $ 6; Africa & Europe — US $ 9; Canada & USA — US $ 11
Edited by Sathyamala, B-7/88/1, Safdarjung Enclave, New Delhi 110029
Published by Sathyamala for Medico Friend Circle Bulletin Trust, 50 LIC quarter University Road, Pune 41106
Printed by Sathyamala at Kalpana Printing House, L-4, Green Park Extn., N. Delhi 16
Correspondence and subscriptions to be sent to—The Editor, F-20 (GF), Jungpura Extn., New Delhi-110014.

DIS 6.2

Pulse Polio Immunization (PPI) in India
Process Evaluation
7 December 1997



Name of interviewer: _____

Designation: _____

Date of Visit: _____ **Time of visit:** _____ **State:** _____

District: _____ **City/Town/Village:** _____

Name of Post: _____ **Post Coordinator:** _____

Type of Post: Urban/rural/urban-slum/resettlement colony/tribal transit points

Contests:

Form I:	Interview of PPI Post Coordinator (person in-charge of post)
Form II:	Observation check list (by independent observer)
Form III:	Exit interview of people leaving the post (4 forms)

DEPARTMENT OF FAMILY WELFARE
MINISTRY OF HEALTH & FAMILY WELFARE
GOVERNMENT OF INDIA, NEW DELHI

1128
9/12/97

INSTRUCTIONS FOR FILLING UP THESE FORMS

As you are an experienced observer, the information you provide us in this evaluation is extremely useful for the programme. Please take time to fill out the attached forms according to the instructions given below which may kindly be noted before filling out the forms. We value your comments and suggestions.

1. Please fill up a complete set of forms including, one Form I, one Form II and four Forms III (one form for each of four children) for each PPI post visited by you.

2. Please fill out one set of forms per post. If you visit more than one post, please copy this set as needed.

3. This is a qualitative survey. Please try to record the responses as they are made by the respondents, without changes. If more than one response is made, record all.

4. Please try to spend some time observing the working at the PPI post before filling up Form 2. The post should have been open for at least two hours before the observations are made.

5. Please tick the relevant answer.

6. Whenever "other" is selected as a response to a question, please try to specify what exactly is meant by "other", using whenever possible the words of the respondent or your own description.

7. An incorrect response (for instance a date other than 18/1/1998 for the next PPI or any other vaccine) should be recorded as "doesn't know" indicating the respondent does not know the correct answer.

8. Please try not to prompt the respondent. This is especially important for questions like no. 6 in Form III where the responses should be recorded as said by the respondent.

9. Please feel free to record your own observations in the spaces provided on Form II. Your valuable observations will enable us to improve the second round on 18/1/1998.

10. In form III, please try to assess and fill in routine immunization and earlier PPI dose coverage of the children interviewed.

11. Kindly post these forms back latest by Monday, 9 December 1997 so that they can be analysed in time to improve the second round of PPI on 18/1/1998. A self addressed envelope is enclosed for this purpose.

Thank you.

Please post all forms by 9 December to:

Dr S. Sarkar
Assistant Commissioner (Imm.), MOHFW
c/o Health Section
UNICEF
73 Lodi Estate, New Delhi 110 003

Form I

INTERVIEW OF THE PPI POST COORDINATOR

1. What is the total number of workers at this post?

Health Workers	_____	**Anganwadi workers**	_____
Teachers	_____	**Students**	_____
NGOs	_____	**Community volunteers**	_____
Armed Forces	_____	**Others (specify)**	_____

_____

2. What is the number of children 0-59 months (less than 5 years) of age expected? _____
3. How many OPV vaccine vials were received? _____
4. Did vaccines arrive - **on time/delayed**
5. What cold chain equipment is available at this post?

   Vaccine carriers _____ **Day carriers** _____ **Others (specify)** _____
6. What communication materials have been received?

   Banner/Flag/Stickers/Posters/Others (specify) _____
7. A) Are there some localities within your catchment area from where children may not come? Yes/No

   B) If yes to part A, please describe these areas:

   _____

   _____

   _____

   C) If yes to part A, what is your plan to reach these areas:

   _____

   _____

   _____
8. Are any children being returned without vaccination? Yes/No. If yes, give reasons:

   _____

   _____

   _____
9. What suggestions do you have for change or improvements?

   _____

   _____

   _____

Form II

OBSERVATION CHECKLIST

1. Were FROZEN ice packs or ice present? **Yes/No**

2. a) Did you find the Vaccine Vial Monitor (VVM) sticker on the vaccine vial? **Yes/No**

   b) If yes, the colour of the square changed to _____ than the circle **Lighter/Same/Darker**

3. Is the age of the child being checked? **Yes/No**

4. Record maintained by: **Tally sheets/Enumeration lists/Names being recorded/**

   Others (specify) _____

   _____

5. Observe 4 children being given polio vaccine: Record the number of drops given to:

   Child No.1 _____ **Child No. 2** _____

   Child No.3 _____ **Child No. 4** _____

6. Is the PPI site easily identifiable? **Yes/No**

7. What are your additional comments or observations about the functioning of this PPI Post (examples: description of physical facility, vaccination skills of person giving vaccine, adequacy of materials, novel ways to identify post, etc.)?

   _____

   _____

   _____

   _____

   _____

EXIT INTERVIEWS WITH PEOPLE LEAVING THE PPI POST (Fill our 4 forms)

CHILD NO. 1

1. How old is your child? _____ **Years** _____ **Months**
2. What vaccine did your child receive today? **Polio/None/Doesn't know**
3. How did you know where and when to come for the vaccine? (Do not prompt)

   Tick (✓) all that apply:

   Health staff _____ **Anganwadi worker** _____

   Teacher _____ **School students** _____

   Relative, friend or neighbour _____ **Other volunteers** _____

   Radio _____ **TV** _____

   Posters, leaflets _____ **Loudspeaker/microphone** _____

   Others _____
4. When is the next Pulse Polio Immunization Day?

   _____ **18 January 1998** _____ **Doesn't know**
5. How will the programme today help your child?

   Prevent polio or eradicate polio/others (specify): _____
6. What suggestions do you have for change or improvement of this programme?

   _____

   _____

   _____

   _____

   _____

   _____

   _____
7. Did your child get routine immunization and/or earlier PPI doses?

Vaccine/dose	BCG	D.P.T.				O.P.V.				P.P.I.				Measles
		1	2	3	B*	1	2	3	B*	Dec 95	Jan 96	Dec 96	Jan 97	
Date/Month/Year OR Age of child in months when this was given.														

* Booster dose

Thank respondent for participation and remind them about the next PPI day on **18 January 1998.**

EXIT INTERVIEWS WITH PEOPLE LEAVING THE PPI POST (Fill our 4 forms)

CHILD NO. 2

1. How old is your child? _____ **Years** _____**Months**
2. What vaccine did your child receive today? **Polio/None/Doesn't know**
3. How did you know where and when to come for the vaccine? (Do not prompt)

   Tick (✓) all that applies:

   Health staff _____ **Anganwadi worker** _____

   Teacher _____ **School students** _____

   Relative, friend or neighbour _____ **Other volunteers** _____

   Radio _____ **TV** _____

   Posters, leaflets _____ **Loudspeaker/microphone** _____

   Others _____

4. When is the next Pulse Polio Immunization Day?

   _____ **18 January 1998** _____ **Doesn't know**

5. How will the programme today help your child?

   Prevent polio or eradicate polio/others (specify):_____

6. What suggestions do you have for change or improvement of this programme?

   _____

   _____

   _____

   _____

   _____

   _____

   _____

7. Did your child get routine immunization and/or earlier PPI doses?

Vaccine/dose	BCG	D.P.T.				O.P.V.				P.P.I.				Measles
		1	2	3	B*	1	2	3	B*	Dec 95	Jan 96	Dec 96	Jan 97	
Date/Month/Year OR Age of child in months when this was given.														

* Booster dose

Thank respondent for participation and remind them about the next PPI day on **18 January 1998.**

EXIT INTERVIEWS WITH PEOPLE LEAVING THE PPI POST (Fill our 4 forms)

CHILD NO. 3

1. How old is your child? _____ **Years** _____**Months**
2. What vaccine did your child receive today? **Polio/None/Doesn't know**
3. How did you know where and when to come for the vaccine? (Do not prompt)

   Tick (✓) all that applies:

   Health staff _____ **Anganwadi worker** _____

   Teacher _____ **School students** _____

   Relative, friend or neighbour _____ **Other volunteers** _____

   Radio _____ **TV** _____

   Posters, leaflets _____ **Loudspeaker/microphone** _____

   Others _____
4. When is the next Pulse Polio Immunization Day?

   _____ **18 January 1998** _____ **Doesn't know**
5. How will the programme today help your child?

   Prevent polio or eradicate polio/others (specify):_____
6. What suggestions do you have for change or improvement of this programme?

   _____

   _____

   _____

   _____

   _____

   _____

   _____
7. Did your child get routine immunization and/or earlier PPI doses?

Vaccine/dose	BCG	D.P.T.				O.P.V.				P.P.I.				Measles
		1	2	3	B*	1	2	3	B*	Dec 95	Jan 96	Dec 96	Jan 97	
Date/Month/Year OR Age of child in months when this was given.														

* Booster dose

Thank respondent for participation and remind them about the next PPI day on **18 January 1998.**

EXIT INTERVIEWS WITH PEOPLE LEAVING THE PPI POST (Fill our 4 forms)

CHILD NO. 4

1. How old is your child? _____ **Years** _____**Months**
2. What vaccine did your child receive today? **Polio/None/Doesn't know**
3. How did you know where and when to come for the vaccine? (Do not prompt)

   Tick (✓) all that applies:

   Health staff _____ **Anganwadi worker** _____

   Teacher _____ **School students** _____

   Relative, friend or neighbour _____ **Other volunteers** _____

   Radio _____ **TV** _____

   Posters, leaflets _____ **Loudspeaker/microphone** _____

   Others _____
4. When is the next Pulse Polio Immunization Day?

   _____ **18 January 1998** _____ **Doesn't know**
5. How will the programme today help your child?

   Prevent polio or eradicate polio/others (specify):_____
6. What suggestions do you have for change or improvement of this programme?

   _____

   _____

   _____

   _____

   _____

   _____

   _____
7. Did your child get routine immunization and/or earlier PPI doses?

Vaccine/dose	BCG	D.P.T.				O.P.V.				P.P.I.				Measles
		1	2	3	B*	1	2	3	B*	Dec 95	Jan 96	Dec 96	Jan 97	
Date/Month/Year OR Age of child in months when this was given.														

* Booster dose

Thank respondent for participation and remind them about the next PPI day on **18 January 1998.**

THE LANCET

Polio Reconsidered

THE efficacy of killed poliovaccine for prevention of poliomyelitis was proven thirty years ago in the placebo-controlled study of Francis and his colleagues in the USA.[1] Despite this proof of effectiveness, the vaccine was superseded in the USA, the UK, and most other countries—for several reasons. First, poliomyelitis epidemics continued to occur in unvaccinated poor areas of the USA and an orally administered vaccine seemed a good way of reaching the disadvantaged members of society. Second, oral vaccine was expected to offer superior gut immunity, breaking the chain of infection as well as preventing disease. Third, orally administered living poliovaccine might spread in the community, thus vicariously immunising those who are difficult to reach by public health programmes. Finally, the oral living vaccine is much cheaper.

Today poliomyelitis is largely controlled wherever living poliovaccine has been used in efficient public health programmes, and also in the few countries—notably, Sweden and the Netherlands—that have relied on killed vaccine, so that reconsideration of the matter is not obviously necessary. There are, nonetheless, several reasons why the vaccines and policies for control of the disease deserve review. Thus, through much of the developing world poliomyelitis remains unchecked and lameness surveys indicate that it is a much more important cause of disability than had been previously supposed. In addition, recombinant DNA techniques have afforded insights into the nature of virulence and the structure of the antigenic sites concerned with protective immunogenicity.[2]

On p 1322 of this issue Dr Kim-Farley and co-workers describe an outbreak of poliomyelitis in Taiwan, in a population well vaccinated with OPV. Oral poliovaccine often gives disappointingly poor immunity and protection in tropical countries; notable examples are described by John in Southern India[3] and Goldblum et al[4] in Israel (particularly the Gaza Strip). It was therefore important to assess whether the cause of the outbreak was a vaccine failure or a concentration of cases in the small unvaccinated segment of the population. In the event, it was established that the vaccine was very effective but that an epidemic can occur in a subpopulation that is poorly immunised. This is the same experience as the Dutch public health authorities had in 1978 in a programme relying on killed poliovaccine with excellent immunisation rates. Thus, there was an extensive outbreak of poliomyelitis amongst the members of a religious sect opposed to immunisation. A reanalysis of this outbreak by Schaap et al[5] shows clearly that the killed vaccine used in the Netherlands was effective, both in protecting the vaccinated and in conferring a herd immunity on non-immunised individuals living in the community, but did not protect the particular religious sect that maintained itself as a distinct subpopulation. The original expectation was that living poliovaccine would be superior in just this regard, and it gained strong support from the observation in the UK that Sabin-related strains of poliovirus have largely replaced wild strains as the poliovirus circulating in the population.[6] The evidence from Taiwan seems to indicate that the benefits of OPV are largely confined to the immunised and that the herd benefit is unlikely to be much superior to that afforded by killed poliovaccine of adequate potency.

The safety of OPV is another consideration. The risk was estimated by a WHO investigation in several ways, of which the most accurate was probably the assessment of risk per million susceptible children. The figure varied between 0·5 and 3·4 per million with a mean of 0·8.[7] In the USA the control of poliomyelitis effected by OPV has been so successful that the spread of infection is curtailed.[8] A consequence is that a high proportion of the cases now occurring in the USA are temporally associated with vaccine in recipients or their contacts and the viruses isolated are confirmed by modern techniques as derived from the Sabin vaccine strains. On p 1315 a paper from the Centers for Disease Control, Atlanta, suggests that endemic cases of poliomyelitis arising in the population in the USA are also vaccine-like and thus, presumably, associated with the wide spread of vaccine-derived strains in the population. There is a danger that these observations may increase litigation against vaccine manufacturers and public health authorities and place in jeopardy the supply of vaccines for the protection of the populations. There should instead be rejoicing at the virtual conquest of poliomyelitis and discussion of the policy options. The findings should also give impetus to the setting up of methods to compensate victims of "vaccine accidents" without resort to litigation. (Any public body set up to compensate victims of a public health programme should be empowered to sue manufacturers for any negligence in production, testing, or promotion, but this option should not be open to the victims themselves.)

1. Francis T Jr, Korns RS, Voight RB, et al. An evaluation of the 1954 poliomyelitis vaccine trials: summary report. *Am J Publ Health* 1955; 45: no 5 (suppl).
2. Almond JW, Stanway G, Cann AJ, et al. New poliovirus vaccines: a molecular approach. *Vaccine* 1984; 2: 177–83.
3. John TJ. Poliomyelitis in India: prospects and problems of control. *Rev Infect Dis* 1984; 6: 438–41.
4. Goldblum N, Sweera T, Chaus BG, et al. The natural history of poliomyelitis in Israel 1949–1982. *Progr Med Virol* 1984; 29: 115–33.
5. Schaap GJP, Bijkerk H, Couvée RA, Kapsenberg JG, van Wezel AL. The spread of wild poliovirus in the well-vaccinated Netherlands in connection with the 1978 epidemic. *Progr Med Virol* 1984; 29: 124–40.
6. Cossart YE. Evolution of poliovirus since introduction of attenuated vaccine. *Br Med J* 1977; 1: 1621–23.
7. WHO consultative group. The relation between acute paralytic spinal paralysis and poliomyelitis vaccine—results of a ten-year enquiry. *Bull WHO* 1982; 60: 231–42.
8. Nathanson N. Eradication of poliomyelitis in the United States. *Rev Infect Dis* 1982; 4: 940–50.

OPV remains the bedrock of most control programmes for poliomyelitis in developed countries. When intensive public health programmes are mounted—as, for example, in Malaysia or Brazil—it can be successful in developing countries too, but it does need an intensive effort and outbreaks of disease can occur, as illustrated by that in Taiwan. A great drawback is the heat lability and short shelf-life of OPV, requiring a well-developed cold chain. Killed poliovaccine, either alone or in combination with living vaccine, is now being investigated for the control of poliomyelitis in several countries.[3,4] In a third paper in this issue (p 1317) Dr Darrell Salk and his colleagues put forward a reasoned case for the use of one or two doses of killed poliovaccine to provide immunological memory. A single dose of potent vaccine at six months of age is sufficient to produce antibodies and stimulate immunological memory as are two doses starting at two months. It is expected that a single dose of killed poliovaccine at two months, or perhaps at birth, will induce immunological memory. Thus, there are good prospects of an alternative strategy for preventing poliomyelitis to that afforded by OPV. A two-dose schedule of killed poliovaccine combined with diphtheria and tetanus starting at two months or less would be very convenient and likely to be successful. We have previously argued that a combined diphtheria-pertussis-tetanus (DPT)/polio vaccine is more likely to achieve high coverage than OPV plus killed DPT. There are two objections to this strategy—anxieties about the pertussis element and the high cost of injected poliovaccine. The cost of injected poliovaccine can be reduced by the use of continuous cell lines such as Vero on microcarrier cultures; also the costs of administration are substantially lessened by use of a combined vaccine. This policy option needs to be explored along the lines advocated by Salk et al. It is important to build confidence in a new programme step by step. The recent withdrawal of batches of poliovaccine in the US and Canada because they had lost potency shows how important it is to validate every step in a new programme.[9] The vaccine made in the Netherlands and described by Salk et al has proved stable, safe, and effective over several years and should form the basis for extended studies of the new policy option. Meanwhile, the work described by Almond et al[2] offers a very exciting prospect for the future development of vaccines. The understanding of virulence and attenuation of polioviruses at the molecular level is proceeding fast. So far, surprisingly few differences have emerged between attenuated and virulent type 3 polioviruses, which bodes well for our understanding of the mechanism and underlines the deficiencies of the type 3 vaccine strain compared with type 1. Such work could lead to better attenuated and killed vaccines in future, but this prospect should not impede the use of the tools we have at present which have so successfully controlled the disease.

9. *Wall Street Journal*, Nov 8, 1984.

Vascular Disease, Senility, and Dementia

ABOUT 1 o'clock in the afternoon of July 25, 1694, and after suffering from palpitations and pissing of blood for many years, the great anatomist and physician to the Pope, Dr Malpighi, was seized with apoplexy with a palsy of the whole right side and distortion of the mouth and right eye. Despite bleeding, cupping, and application of the powder of Cornachini and Sinapismus to the soles of his feet he recovered from the palsy after 40 days but was left somewhat demented, impaired in memory and reason with emotional weakness, melting into tears upon the slightest occasion, with intervals of inappetency and slight fits of giddiness.[1] On Nov 29 that year he had a further apoplectic fit and died. A week later, George Baglivi dissected his corpse. The heart was larger than ordinary and there were about 2 pints of black clotted blood in the brain. The blood vessels of the brain were dilated and broke on all hands.[2]

Alzheimer, in 1906 and 1907, distinguished a specific kind of dementia, named after him by Kraepelin and first thought of as a presenile psychosis in which signs of arteriosclerotic change in the brain were distinctly rare.[3,4] The brain was diffusely shrunken, sometimes with a thickened pia-arachnoid, and with two virtually constant histopathological changes—senile plaques and intracellular fibrillary lesions. Patients with Alzheimer's disease had symptoms of an enfeebled mind, confusion, restlessness, excitement, or hallucinosis rather than the sudden stroke and focal signs of Dr Malpighi. One peculiarity of Alzheimer's disease is its onset before old age is imagined to begin, but nearly all examples can be grouped with other cases of senile dementia in which there are senile plaques and neurofibrils. Old age itself is unlikely to be a disease and Critchley in 1930 found there were no "senile" plaques in the brain of two persons aged 101 and 103.[5]

These two histological correlates of vascular and parenchymal dementia are easily recognisable by neuropathologists. The dementia of cerebral arteriosclerosis is probably due to multiple cerebral infarctions[6-8] and is commonly referred to as multi-infarct dementia.[9] This is sometimes associated with the white matter degeneration and demyelination of

1. Major RH. The history of the sickness of Marcellus Malpighi, the Pope's physician; with an account of the dissection of his corpse. In: Classic descriptions of disease. Springfield: Thomas, 1945: 476–77.
2. Baglivi G. The practice of physick. London: Bell, 1704: 441.
3. Alzheimer A. Über eigenartige Krankheitsfälle des späteren Alters. *Z Neurol Psychiat* 1911; 4: 356–85.
4. Alzheimer A. Über eine eigenartige Erkrankung der Hirnrinde. *Allg Z Psychiat* 1907; 64: 146–48.
5. Critchley M. The pathology of the senile psychoses. *Proc Roy Soc Med* 1930; 23: 533–43.
6. Fisher CM. Dementia and cerebral vascular diseases. In: Toole JF, Siekert RG, Whisnant JP, eds. Cerebral vascular diseases (6th Princeton Conference). New York, 1968.
7. Wells-Petersen J, Feldenberg H. Atherosclerosis of cerebral arteries, pathological and clinical correlations. *Acta Neurol Scand* 1967; 43 (suppl 31).
8. Brunner MG. Les conceptions actuelles des démences artériopathiques. *L'Encéphale* 1977; 3: 357–72.
9. Hachinski VC, Lassen NA, Marshall J. Multi-infarct dementia, a cause of mental deterioration in the elderly. *Lancet* 1974, ii: 207–10.

Efficacy of inactivated poliovirus vaccine in India*

R. KRISHNAN,[1] MALATI JADHAV,[2] & T. JACOB JOHN[3]

The immunogenic efficacy of inactivated (Salk) poliovirus vaccine (IPV) was evaluated in infants in India, in view of the high frequency of vaccine failure after immunization with oral (Sabin) poliovirus vaccine (OPV). A total of 150 infants, aged 6–45 weeks, were given 3 doses of IPV, with intervals of 4 or 8 weeks between doses. The effect on the antibody response of child's age, presence of maternal antibody before immunization, and interval between doses was assessed. The overall seroconversion rates to poliovirus types 1, 2, and 3 were 99%, 89%, and 91%, respectively. Seroconversion rates to types 2 and 3, and antibody titres to types 1 and 2, were higher (i) in infants given vaccine doses at 8-week intervals and (ii) in those without detectable maternal antibody. The seroconversion rates in infants without maternal antibody, who were given IPV at 8-week intervals, were 100%, 100%, and 96.2% to poliovirus types 1, 2, and 3, respectively. Thus the immunogenic efficacy of IPV was found to be satisfactory.

Although the oral (Sabin) poliovirus vaccine (OPV) has been shown to be effective in the control of poliomyelitis in many countries, there are two reasons why an evaluation of the alternative, inactivated (Salk) poliovirus vaccine (IPV) has become necessary. First, in some developing countries, especially in the tropics, the immunity induced by the conventional three doses of OPV has been incomplete (*1*). Consequently, the incidence of paralytic poliomyelitis in vaccine recipients has been unacceptably high (*2, 3*). Second, in some developed countries where poliomyelitis due to wild poliovirus infection has become rare, the very small risk of paralytic illness associated with the oral vaccine virus has assumed a greater importance (*4*).

We have investigated the immunogenic efficacy of IPV in infants in a tropical area of south India. The results, we believe, have wide relevance.

MATERIALS AND METHODS

The general setting of the study was similar to that described in earlier reports on the efficacy of OPV (*1, 5*). Briefly, infants between 6 and 45 weeks of age attending the immunization clinic were offered a quadruple vaccine incorporating IPV with diphtheria-pertussis-tetanus vaccine.* Each dose of 1 ml contained 20, 2, and 3.5 D antigen units of poliovirus types 1, 2, and 3, respectively. Three doses were given to infants intramuscularly, at 4-week or 8-week intervals according to the week in which the first dose was given. Blood was collected from all infants by finger or heel prick before giving the first dose and again, 4 weeks after the third dose. All sera were tested in pairs for the presence and titre of poliovirus neutralizing antibody, using doubling dilutions from 1:8 to 1:1024, as described previously (*1, 5*).

In infants without detectable antibody before immunization, the appearance of antibody at any titre was considered indicative of seroconversion. Any antibody present prior to immunization in infants up to 6 months of age was considered to be maternal in origin. Since the half-life of passively acquired IgG is 3–4 weeks, it was assumed that, in the absence of seroconversion, the antibody level would have declined to one-eighth or less when the second blood sample was collected 12 or 20 weeks later. Antibody titres 4 or more times higher than this expected level were accepted as indicative of seroconversion. In the calculation of the geometric mean titre (GMT), titres of sera showing no end-point at 1024 were taken as 1024. The mean seroconversion rate to the three serotypes was termed the seroconversion index (*6*).

RESULTS

Although 240 infants were recruited to the study only 152 completed it. Their preimmunization anti-

* From the Christian Medical College Hospital, Vellore, Tamil Nadu 632004, India. Requests for reprints should be addressed to Professor T. J. John.

[1] Formerly Registrar, Department of Child Health. Present address: Department of Paediatrics, University Hospital, Kuala Lumpur, Malaysia.

[2] Professor of Paediatrics, and Head, Child Health Unit.

[3] Professor and Head, Department of Virology, and Programme Director, Indian Council of Medical Research Centre of Virology.

* Supplied by the Rijks Institute, Bilthoven, Netherlands

body status is summarized in Table 1. Two 28-week-old infants with antibody against poliovirus type 1 and/or type 2 were excluded from further analysis.

The antibody response of the remaining 150 infants, according to age and the interval between doses, is summarized in Table 2. In infants under 8 weeks of age at the start of immunization, the seroconversion rate to type 2 virus was significantly higher when the doses were administered at 8-week intervals rather than at 4-week intervals ($P < 0.01$). Seroconversion rates to types 1 and 3 were also generally higher with a longer interval between doses, but the differences were not statistically significant.

The type-specific seroconversion rates in infants with and without maternal antibodies before immunization are presented in Table 3. In infants without maternal antibody, the response to type 1 poliovirus was 100% irrespective of the interval between doses. Although response rates to poliovirus types 2 and 3 were lower when doses were given at 4-week intervals, the differences were not significant. Among infants with maternal antibodies, those receiving IPV at 4-week intervals responded poorly to types 2 and 3 poliovirus, but those receiving the vaccine at 8-week

Table 1. Prevalence of poliovirus antibody in infants immediately before immunization

Age (weeks)	No. of children tested	Infants without antibody		No. with antibody			Infants with all 3 antibody types	
		No.	%	Type 1	Type 2	Type 3	No.	%
6–7	90	27	30	50	42	14	11	12
8–12	26	11	42	7	14	3	2	8
13–26	26	21	81	4	2	2	1	4
27–45	10	8	80	2	1	0	0	0
Total	152	67	44	63	59	19	14	9

Table 2. Antibody response to poliovirus immunization according to age and interval between doses

Age at first dose (weeks)	Interval between doses (weeks)	No. tested	Seroconversion						Seroconversion index (%)
			Type 1		Type 2		Type 3		
			No.	%	No.	%	No.	%	
6–7	4	57	56	98	40	70	50	88	85.4
	8	33	33	100	33	100*	32	97	99
8–12	4	10	10	100	8	80	10	100	93.3
	8	16	16	100	15	94	15	94	95.8
13–26	4	19	18	95	19	100	17	89	94.7
	8	7	7	100	7	100	6	86	95.2
27–45	4	3	3	100	3	100	2	67	88.9
	8	5	5	100	5	100	5	100	100
6–45	4	89	87	98	70	79	79	89	88.4
	8	61	61	100	60	98*	58	95	97.8
Total	4 and 8	150	148	99	130	89	137	91	92.1

* Significantly different from seroconversion rate with 4 week intervals between doses, $P < 0.01$.

Table 3 Type specific seroconversion rates after 3 doses of IPV in infants with and without maternal antibody, before the first dose

Maternal antibody	Interval between doses (weeks)	Type 1		Type 2		Type 3	
		No. with antibody/ No. tested	%	No. with antibody/ No. tested	%	No. with antibody/ No. tested	%
Absent	4	53/53	100	58/63	92	74/80	92.5
	8	30/30	100	30/30	100	51/53	96.2
Present	4	34/36	94.4	12/26	46.2	5/9	55.6
	8	25/25	100	30/31	96.8*	7/8	87.5

* Significantly different from seroconversion rate with 4-week interval between doses, $P < 0.01$

intervals showed a good response. The difference was significant only in the case of type 2 poliovirus ($P < 0.01$).

The post-immunization GMTs of poliovirus antibodies in infants with and without maternal antibodies before immunization are shown in Table 4. The preimmunization GMTs of antibodies to poliovirus types 1, 2, and 3 were 17, 18, and 14, respectively, in infants immunized at 4-week intervals and 16, 16, and 17, respectively, in those immunized at 8-week intervals. Irrespective of the presence or absence of maternal antibody before immunization, antibody titres to all types of poliovirus were higher in the group given doses at 8-week intervals. Similarly, regardless of the interval between doses, the titres of antibody to poliovirus types 1 and 2 were higher in those without maternal antibody before immunization.

Table 4. The post-immunization geometric mean titres (GMT) of poliovirus antibody in infants who showed seroconversion, according to presence or absence of maternal antibody before immunization

Maternal antibody	Interval between doses (weeks)	GMT of antibodies to poliovirus		
		Type 1	Type 2	Type 3
Absent	4	311.2[a]	77.7	86.7
	8	632.4[b]	194.0	97.0
Present	4	190.1	24.1[b]	80.6
	8	347.3	137.2	98.7

[a] Significantly different from (i) GMT with 8-week interval between doses, and (ii) GMT in infants with maternal antibody, given doses at 4-week intervals ($P < 0.05$).

[b] Significantly different from GMT in infants with maternal antibody, given doses at 8-week intervals ($P < 0.05$).

DISCUSSION

Since the immunogenic efficacy of IPV has not previously been evaluated in India, the first objective of the present study was to establish the seroconversion rates in infants given the vaccine. The results presented here confirm the high immunogenic efficacy of the presently available IPV in Indian infants, especially when given after 7 weeks of age or at 8-week intervals. Preliminary results showing a satisfactory response in triple seronegative infants have been briefly reported earlier (*7*).

We have evaluated the effects on antibody response of three factors, namely, age, presence of maternal antibody, and the interval between doses. Age and the presence of maternal antibody are interrelated, as shown in Table 1. By 6 weeks of age, nearly one-third of infants had become seronegative and only 12% had antibodies to all three poliovirus types. As immunization is usually started at 6 weeks of age in India, 2 months in the USA, and 3 months in the United Kingdom, the results were analysed in terms of these three age categories. The effect of interval between doses was most marked in infants under 2 months of age; IPV should be given to these infants at 8-week intervals to obtain a satisfactory response.

The adverse effect of maternal antibody on immune response to IPV has been shown earlier (*8*). This effect is reduced by increasing the interval between doses from 4 to 8 weeks. The results presented in Tables 3 and 4 indicate that maternal antibody and the interval between doses are the two factors with greatest effect on the antibody response. The best response, particularly to types 1 and 2 poliovirus, was obtained in infants without maternal antibody given vaccine at 8-week intervals; the poorest response was seen in infants with maternal antibody given doses at 4-week intervals.

In a recent review of IPV (*9*), the quantity of

antigen, the number of doses, vaccine potency, and immunological adjuvants were listed as factors influencing the antibody response; the interval between doses was not recognized as such a factor. Our results show clearly that an 8-week interval between doses produces a better antibody response than does a 4-week interval. This finding is of immediate relevance to countries where IPV is used for immunization of children. The vaccine used in this study is currently licensed and used routinely in the Netherlands. The antigenic content of the type 1 component is adequate for use in India, but the antigenic content of types 2 and 3 could be increased to produce a better response, especially if immunization is to be started at 6 weeks of age. Given in 3 doses at 8-week intervals, the present formulation is quite satisfactory.

ACKNOWLEDGEMENTS

We are indebted to Dr Hans Cohen and Dr A. L. Van Wezel of the Rijks Institute, Bilthoven, Netherlands, for the supply of the vaccine; to Dr Jonas Salk for suggesting that IPV be evaluated in India; and to Mr R. Selvakumar for technical assistance.

Financial support was provided by the Indian Council of Medical Research, New Delhi, and the Forum for the Advancement of Immunization Research, Paris, France.

RÉSUMÉ

EFFICACITÉ DU VACCIN ANTIPOLIOMYÉLITIQUE INACTIVÉ EN INDE

La grande fréquence des échecs de l'immunisation par administration du vaccin antipoliomyélitique oral (Sabin) a conduit à évaluer l'efficacité immunogène du vaccin antipoliomyélitique inactivé (VPI) (Salk). Au total, 150 nourrissons, âgés de 6 à 45 semaines, ont reçu 3 doses de VPI, à des intervalles de 4 semaines pour les uns, de 8 semaines pour les autres. On a évalué l'effet sur la réponse en anticorps de l'âge de l'enfant, de la présence ou de l'absence d'anticorps maternels chez l'enfant avant sa vaccination, et de l'intervalle entre les doses. Le taux global de séroconversion pour les poliovirus de type 1, 2 et 3 a été de 99%, 89% et 91% respectivement. Les taux de séroconversion pour les types 2 et 3 et les titres d'anticorps contre les types 1 et 2 étaient plus élevés chez les nourrissons ayant reçu les doses de vaccin à 8 semaines d'intervalle, et aussi chez les enfants ne présentant pas d'anticorps maternels décelables. Les taux de séroconversion chez les enfants dépourvus d'anticorps d'origine maternelle et qui avaient reçu le VPI à intervalles de 8 semaines s'établissaient à 100%, 100% et 96.2% pour les poliovirus de types 1, 2 et 3 respectivement. On peut donc en conclure que l'efficacité immunogène du VPI est satisfaisante.

REFERENCES

1. JOHN, T. J. & JAYABAL, P. Oral poliovaccination of children in the tropics. 1. The poor seroconversion rates and the absence of viral interference. *American journal of epidemiology*, 96: 263–269 (1972).
2. JOHN, T. J. Problems with oral poliovaccine in India. *Indian pediatrics*, 9: 252–256 (1972).
3. RATNASWAMY, L. ET AL. Paralytic poliomyelitis. Clinical and virological studies. *Indian pediatrics*, 10: 443–447 (1973).
4. NIGHTINGALE, E. O. Recommendation for a national policy on poliomyelitis vaccination. *New England journal of medicine*, 297: 249–253 (1977).
5. JOHN, T. J. Oral poliovaccination of children in the tropics. 2. Antibody response in relation to vaccine virus infection. *American journal of epidemiology*, 102: 414–421 (1975).
6. JOHN, T. J. & CHRISTOPHER, S. Oral polio vaccination of children in the tropics. 3. Intercurrent enterovirus infections, vaccine virus take and antibody response. *American journal of epidemiology*, 102: 422–428 (1975).
7. KRISHNAN, R. ET AL. Immune response of infants in tropics to injectable poliovaccine. *British medical journal*, 284: 164 (1982).
8. PERKINS, F. T. ET AL. Serological response of infants to poliomyelitis vaccine. *British medical journal*, 2: 68–71 (1958).
9. SALK, J. E. & SALK, D. Control of influenza and poliomyelitis with killed virus vaccines. *Science*, 195: 834–847 (1977).

WILL MUMBAI BE POLIO-FREE BY THE YEAR 2000?

The polio eradication programme has had impressive results. But loopholes still need to be plugged, writes **Janaki Krishnamoorthi**

As we know, the incidence of polio is on the increase in the rainy season. But this monsoon, just eight indigenous cases were reported in Mumbai, as against 65 in 1994. This is an obvious result of the Pulse Polio Immunisation (PPI) programme of 1995.

PPI is part of the global programme to eradicate Poliomyelitis by the year 2000 and it is the last important thrust in the whole process. It can be effective only if the coverage by regular programmes is 90 per cent. For the past six years in Mumbai alone, this coverage has fluctuated between 90 -94 per cent. Besides the routine three- plus booster dosages for all newborns, the BMC health department has Mop Up Rounds prior to the rainy season, when the incidence of polio is the highest. This is the time when extra doses of OPV are given to children in slums and polio pock[illegible]like Chembur and Kandivli. In ad[illegible]on, the civic administration also carries out Ring Immunisation for suspected cases of polio. This entails additional doses of OPV given to 5,000 children in affected areas within 24-48 hours and once again after a month.

Under the surveillance system, every case of paralysis of the limbs in children— Acute Flaccid Paralysis (AFP) — is reported in. After testing the stools of these children for the presence of the polio causing virus, these cases are classified into polio and non-polio.

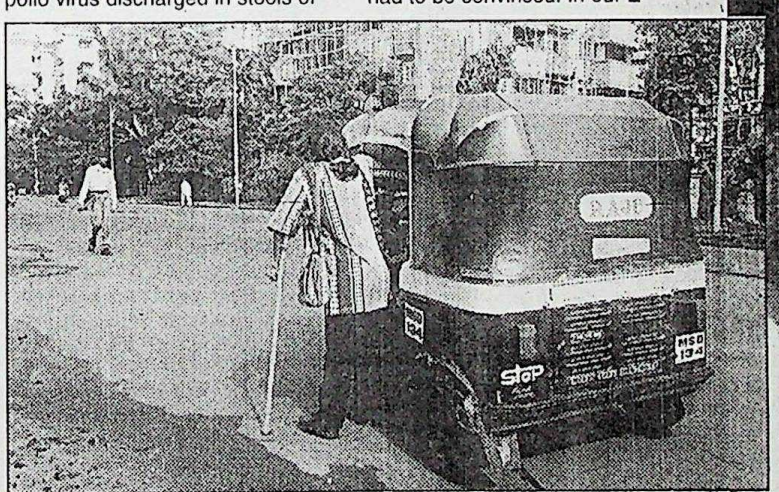
The sustained efforts have brought down the polio cases in Mumbai from 1124 in 1987 to 271 in 1996. Still, they account for 45 per cent of cases in Maharashtra.

The density of population and poor environmental sanitation in urban areas like Mumbai, facilitate quick and easy transmission of the polio virus discharged in stools of children. The migration of population from other areas also makes it difficult to contain it. Notes Dr Ulhas Barve, officer on special duty (expanded programme of immunization) of the BMC, "The influx of people is a major problem for us. Most of the cases reported in Mumbai are actually outside cases. For instance, of the 171 polio cases reported last year, only 54 were indigenous, while 117 were mostly from places like Thane, Bhiwandi, UP and Bihar."

The overall coverage under PPI '96-'97, in Mumbai was 99.38 per cent. Says Dr Rajesh Parikh, consulting psychiatrist at Jaslok Hospital, who is involved in the PPI programme as a Rotarian, "The response was good and only a few had to be convinced. In our E

HOW INDIVIDUALS CAN HELP

- **By getting every child (below five years) immunised at PPI progrmmes**
- **By reporting any recent case of paralysis of the limbs in children with full name/ address of the child to the medical officer at the nearest municipal ward or on telephone nos. 418 3602/ 413 4560 to Dr Barve/ Mr Dalvi/ Mr Surkund.**



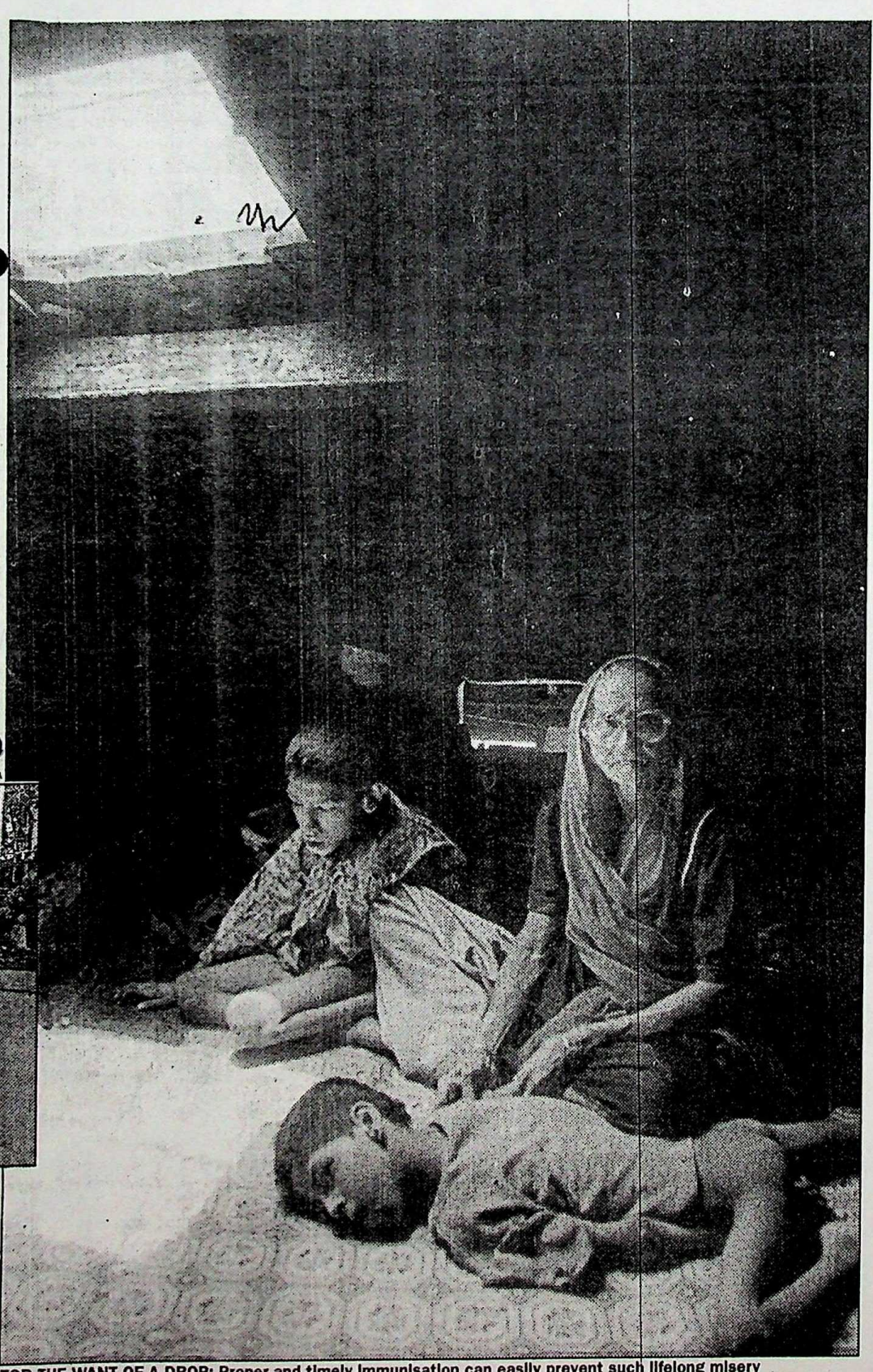
Polio scenario in Mumbai (from 1993 to 1997)

Year	Number of indigenous cases	Number of imported cases	Total
1993	84	97	181
1994	130	200	330
1995	58	127	185
1996	54	117	171
1997(up to 30 Sept)	14	95	109 (16 pending investigation)

Sourced from BMC Health Department

FOR THE

ward, des
Kamathip
major diff
have a g
people."
Surpris



FOR THE WANT OF A DROP: Proper and timely immunisation can easily prevent such lifelong misery

ward, despite areas like Kamathipura, we experienced no major difficulties. The BMC doctors have a good rapport with the local people."

Surprisingly, the response was not so good in the affluent areas of Cuffe Parade, Juhu and Malabar Hill. This was because of an unwillingness on the part of the residents to visit BMC booths located in poor localities. A majority of them had been advised by their private practitioners that it was not necessary for the children to take the extra doses since they were already immunized.

Thus, convincing the upper strata of the society directly and through their doctors, is one of the main objectives of the organisers this year. "We have realised that our approach must suit the needs and fears of the target population. We are planning to involve private practitioners in a big way," avers Dr Parikh.

The resistance to PPI generally revolves around two major issues — an apprehension that the additional doses of OPV will harm the children. And parents are not convinced to go in for the extra dose when children have already been immunized. Dr Prakash Gurnani, programme officer - health at UNICEF, dispels these fears and doubts: "The additional doses will not cause any harm to the children. Even a sick child can be given the vaccine. It is essential for every child below five to be administered the extra dose of OPV in the larger interest of society. To eradicate polio, we have to eliminate the wild virus totally from the environment. For this purpose, we are flushing the environment with a vaccine virus which will arrest the transmission of the wild virus."

Dr Barve adds: "The wild virus will settle down in any area without the extra vaccine coverage. The children in that area, particularly the unprotected, will be prone to the disease. Can you be sure your child is protected? Any break in the cold chain before the vaccine reaches the beneficiary, can reduce the efficacy of the vaccine. Even if the vaccine's potency is maintained, out of 1000 children immunized, only 85 can be assured of total protection. Hence it is necessary that every child be given these extra doses."

Polio can be considered as eradicated from India only if there are no cases reported from any part of the country for three consecutive years. Will the goal be achieved? Opines Dr Gurnani,"If we have to eradicate Poliomyelitis by the year 2000, then we should have zero cases from 1998. Is this possible? We are attempting to achieve this goal but, I as an epidemiologist, feel that we may require more time."

The next PPI, a third in the series, is scheduled for December 7, 1997, and then later for January 18, 1998, when children upto the age of five, from all over the country, will be administered two additional doses of OPV.

In Mumbai, where about 10.55 lakh children are targeted, the BMC along with the WHO, UNICEF, Rotary International and several government and non-government agencies, are gearing up for the massive task to be undertaken at an estimated cost of Rs 1.25 crore.

28 JAN 1997

THE PIONEER
(DELHI)

1/3

Vaccines do save lives

Immunisation is a must — scare stories notwithstanding, says Dr Harshvardhan

Almost two hundred years after Edward Jenners discovery of the vaccine, immunisation is saving the lives of approximately 9 million children a year, worldwide. A further 16 million cases could be prevented each year with effective vaccines deployed against all vaccine preventable diseases.

Since the mid eighties, when the WHO and UNICEF — inspired global effort to bring universal child immunisation really got underway, child deaths have fallen considerably.

Immunisation: The story so far

Immunisation is quite literally a lifesaver, especially in a country like India with its high rates of child malnutrition and poor environmental sanitation. Poor children in poor countries die largely from preventable causes, and the major and affordable way of combatting these deaths is immunisation. The pattern of disease reduction in the country over the last five years or so, with low rates of polio, neo-natal tetanus, measles and diphtheria, clearly point to the national vaccination programmes as the main reason for this reduction. Reduction of neo-natal tetanus is an indicator of a successful vaccination programme. Neo - natal tetanus deaths have come down to 90 per cent in the country from11849 in 1988, to around 1150 in 1996 (until November). The table on the right indicates that only after over 75 per cent tetanus toxoid coverage of pregnant women was achieved, was a reduction in NNT cases sustained. We all know that the environmental and personal hygiene situation, has not changed significantly during these years. Similarly, with polio, as the immunsation coverage increased to 86 per cent, so the number of polio cases decreased by 70 per cent. Immunisation against measles has also been successful in reducing the number of reported cases. The epidemic of measles in Badaun district of Uttar Pradesh, during February to July, 1996, where 236 children were affected and 66 died, occurred among unimmunised children. So far, Only one disease — small pox — has been eradicated by vaccines, saving approximately 5 million lives annually. Polio could be next. Over 80 per cent of the world's children are now being immunised against the polio virus and the annual number of cases, has been cut from 400,000 in 1980 to fewer than 100,000 by the mid nineties, and 145 countries including all of those, in north and south America, reported zero cases of polio in 1993. However, polio cannot be eradicated anywhere, unless it has been eradicated everywhere. In 68 countries, the wild polio virus, is still circulating including some of the largest and poorest countries of South Asia. It can be eradicated by maintaining high levels of routine immunisation, combined with driving out the wild polio virus through special mass immunisation days, and then by detecting and following up each suspected case. Saturday, January 18, was an important day, in the quest to eradicate polio. On this day, six Asian countries, which together account for 80 percent of the world's polio cases, held mass immunisation campaigns. Millions of children in the age group 0-5, including an estimated 120 million in India alone, received the oral polio vaccine. In India, this was the second year, that the Pulse Polio Immunisation days have been held. In Delhi, it is the third year of sustained coverage. It is widely believed that the fight against polio, is now in the final, crucial stages. No public health programme in the country has received such wide commitment and practical support as Pulse Polio.

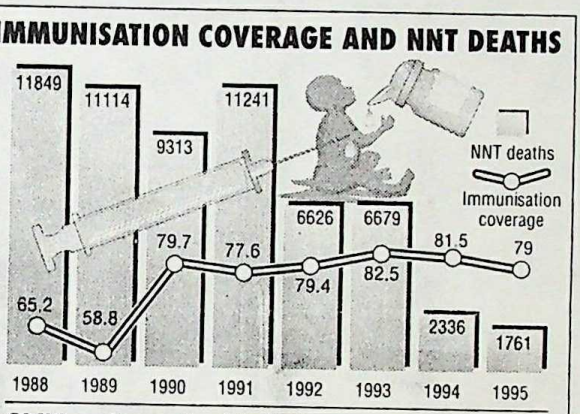
The process evaluation of PPI on December 7, 1996, indicated that there were on average, over seven people in each booth, and fewer than one quarter were from the health sector. Teachers, students, *anganwadi* workers, NGO staff, community workers and others made up the rest. The country mobilised, nearly 50 lakhs of people to staff the booths alone

Despite some scare stories, the oral polio vaccine is safe and it is important that every child is protected. Even if a child has been immunised; another dose boosts a child's immunity, and helps to drive out the wild polio virus, contributing to a polio free country.

The author is Delhi's Health Minister

Progress of immunisation

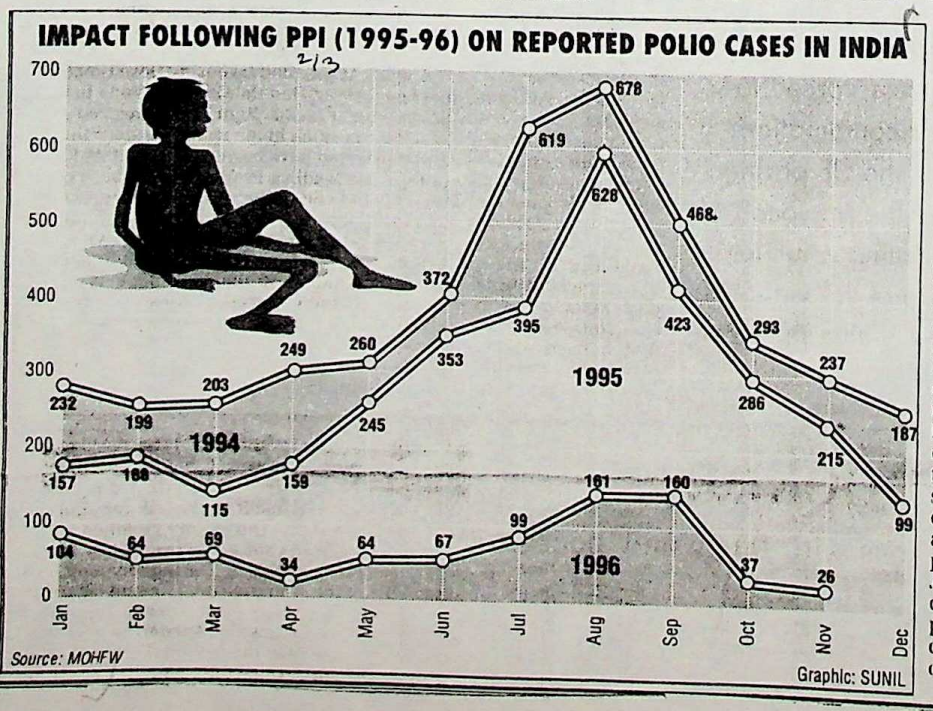
Diseases	Annual deaths if no immunisation	Prevented	Occuring	Percentage prevented
Smallpox	5.0 million	5.0 million	–	100
Diptheria	260,000	223,000	37,000	86
Whooping Cough	990,000	630,000	360,000	64
Measles	2.7 million	1.6 million	1.1 million	60
Neonatal tetanus	1.2 million	0.7 million	0.5 million	58
Hepatitis B	1.2 million	0.4 million	0.8 million	33
Tuberculosis	3.2 million	0.2 million	90,000	6
P[illegible]cases of life-lo[illegible]paralysis)	640,000	550,000	2.2 million	86
Malaria/other parasitic infections	2.2 million	–	1.3 million	0
HIV/STDs	1.3 million	–	1.3 million	0
Diarrhoea/enteric fevers*	3.0 million	–	3.0 million	0
Acute respiratory infections	3.7 million	–	3.7 million	0



Children Immunized in India

Age		9 December, 95	20 January, 96
0-3	Rural	54,358,272	56,254,592
	Urban	16,825,403	18,825,867
above 3		8,477,345	8,038,120
Total		**87,771,343**	**93,118,579**

Source: MOHFW Graphic: SUNIL



Source: MOHFW Graphic: SUNIL

Ending polio: Is it a case of now or nev

Under the impact of a 20-year effort, polio is in retreat. Worldwide, the estimated number of cases has fallen from 400,000 in 1980 to just over 100,000 in 1993. Of 213 countries under surveillance, 145 reported zero cases in 1993. Confidence is therefore running high that the goal of eradicating polio by the year 2000 will be met. Such confidence is dangerous.

Polio can not be eradicated anywhere until it is eradicated everywhere. There are some 68 countries in which wild polio virus is still circulating. Some of those countries —Bangladesh, India, Pakistan—are among the largest and poorest. Others, like Ethiopia or Nigeria, have weak health infrastructure. One or two, like Myanmar, have not so far shown a real commitment to polio eradication. Still others, such as Azerbaijan and Uzbekistan, are witnessing new polio outbreaks as health systems deteriorate. And in many nations, from Afghanistan to Rwanda, the effort is being sabotaged by conflicts and their aftermath. Adding to these difficulties, some of the donor nations are dragging their feet.

No hiding-place

Stage one on tile road to eradication is a high level of routine coverage with oral polio vaccine (OPV). This reduces polio to low levels.

Stage two involves blitzing the virus in a series of national immunisation days, during which all under-fives are given two doses of OPV. This immunises those missed by routine coverage, and boosts the immunity of the already vaccinated. So far, 58 countries have held national immunisation day. In 1994, for example, China reached 83m children in two days.

After this, the polio virus has few hiding-places (it can not live for more than a few months without a human host). And the stage is now set for the final act.

Stage three demands a change in approach. Every suspected case of polio must now be detected by national surveillance systems backed by laboratories. If paralysis is found to be caused by wild polio virus (other viruses can mimic polio), then a supplementary immunisation effort must be targeted to the outbreak. In this way, the last hiding-places of the infection are discovered and eliminated.

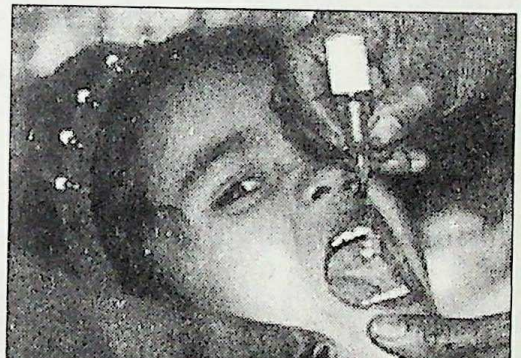
If the effort to eradicate polio is to fail, then it will fail here at this final stage. Large quantities of vaccine are needed and the surveillance systems, especially the laboratories, can be expensive. Meanwhile pneumonia, diarrhoeal disease, malaria, AIDS, are afflicting large numbers. Why should countries devote several million dollars to eradicating a virus which now affects only a handful of children a year?

No doubt people will say that the year 2000 is only a symbolic date, and that it doesn't really matter whether eradication is achieved in 2000, or 2005 or 2010. But this is an even more dangerous fallacy.

To see why, let us place ourselves at some date early in the next century. Polio has been almost but not quite eradicated. Very few cases are occurring. And it is now almost impossible for countries to continue devoting millions of dollars a year to the few remaining cases. The perceived threat has faded. And so has the political momentum. Donor countries cannot be persuaded to keep up the funding. With the momentum lost, even routine immunisation levels may begin to fall.

Meanwhile the very low incidence of polio means an ever-increasing population of young people who are neither vaccinated nor immune through natural infection (most cases of polio are mild, with no long-term consequences). In this way, the potential for a polio epidemic slowly builds up in the early years of the next century.

When that epidemic breaks it will be more difficult to cope with. The large pool of unprotected children will include older children (for whom polio is usually more serious), and efforts to surround outbreaks may then have to be aimed not just at under-fives but at a much larger group of under-tens or even under-fifteens. Secondly, 'failure' will make it harder to mount another eradication attempt. Remember the effort to wipe out malaria? When it failed, mobilising support for further attempts at malaria control became almost impossible.



A child being immunised on January 18, 1996

Eradicating polio requires a head of steam. This we now have. But if the year 2000 target is not achieved, then that pressure will quickly be lost. We will have to start with cold water all over again.

It is therefore not a case of "if not by the year 2000, then soon after". Indeed, it may well be a case Of 'now or never'.

Pioneering

The case for seizing the present opportunity to eradicate polio goes deeper than this. In particular, its cost-effectiveness needs to be weighed in a wider scale. First of all, polio eradication is integrated into the worldwide vaccination programme, strengthening and being strengthened by the immunisation systems. Second, it pion bringing other major diseases under measles to pneumonia. In the years ah be an increasing need to shift from 'inp to 'outcome' approaches — form serv to ever more competent epidemiol quires different skills and strategies — 'learned by doing' in the final stages cation.

More intangibly, eradication would Success breeds success. And another ry would help to motivate the millions daily struggle for health throughout th

Economics:

Finally, eradication makes obvious ec

If the world remains in the limbo of but-not-quite' stage of polio eradicatio cination will have to be maintained in If eradication is achieved, all countries c cination.

Polio immunisation costs about $270 m in the United States and about $200 m in Western Europe. The cost for the worl is many times greater.

The effort to eradicate polio would th for itself within a relatively short time – eradication of smallpox has paid for itself over in the last two decades.

The last stage of this struggle will be d ticularly in countries affected by conflict. sonable to suggest that the industrialis should ensure funding.

For it is to the industrialised nations tha est savings will accrue. The total amou nal aid needed over the final five years will be approximately $ 130 million a year. States along will save twice that much ever the virus is gone. The savings to the develo tries will also be significant. Only in the therefore, is polio eradication competing health resources.

Once achieved, it will actually release the struggle against other threats to hum Following the victory over smallpox in there is now no doubt that polio can becor ond major disease to be banished from the have the technologies and the strategies. sent time, we also have the momentum. A be a tragedy if it does not carry us throu nal victory over poliomyelitis.

Dr Jong Wo

The author is director, Global Progr Vaccines and Immunisat

The articles above are in respo an earlier article on this page 'Vaccine shots can kill' by Alan

TIMES OF INDIA 14/12/97

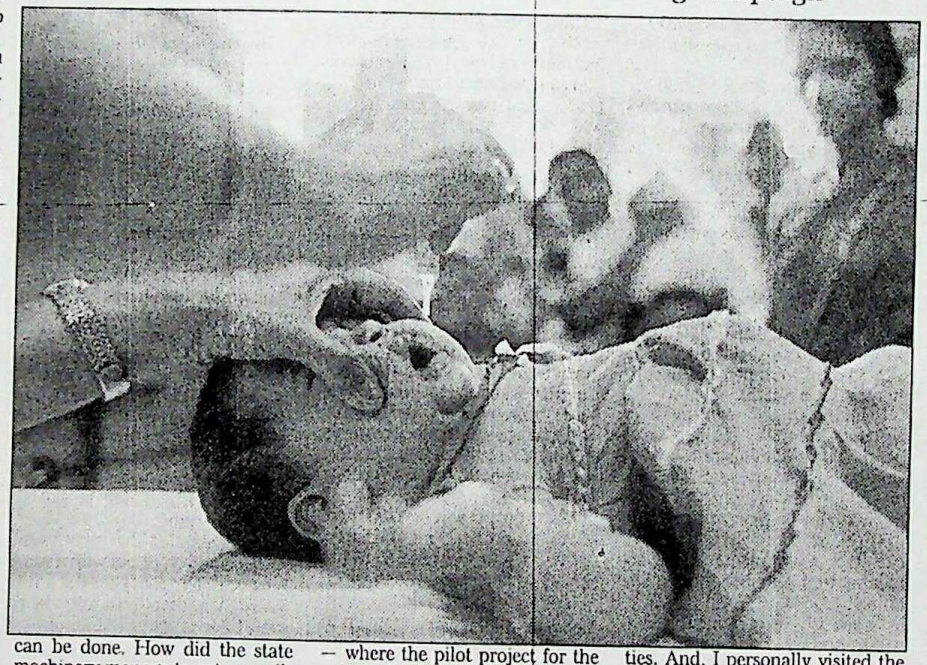
D70C

The pulse of the nation

An awareness blitzkrieg accompanied the National Pulse Polio drive. This is what took it to every corner of the country. **Malathy Iyer** on the vision and mechanism behind this winning campaign

14/12/97 MOGS

* *As the band marched to the rhythmic beat of the drum during a rally organised by the Rotary Club in Delhi, a helicopter scattered pamphlets on the importance of immunising children against polio.*
* *At local mosques and gurudwaras all over the country, daily prayers were followed by announcements reminding devotees of the National Pulse Polio Immunization Day.*
* *The police-patrol vehicles in Bangalore used their loudspeakers to spread the message in different localities.*
* *A jet-setting Mumbai executive, father of a one-year-old boy, was amazed to receive a message on his Max Touch mobile reminding him that it was the Pulse Polio Immunization Day.*



INDEED, it was impossible to miss the message in the awareness blitzkrieg. December 7, 1997, and January 18, 1998, have been indelibly marked in the minds of parents as the days on which their children would be administered the Oral Polio Vaccine (OPV). The Government of India, along with UNICEF and the Rotary Club, has left no stone unturned to ensure that the polio virus is eradicated by the turn of the millennium: hoarding, posters, stickers, pamphlets, and, of course, satellite television channels flashed the message.

The Pulse Polio Drive (so called as it begins at the pulse of 8.00 a.m. all over the country and winds up by 5.00 p.m.) was a great leveller, managing to cut across social barriers, as the rich and the poor of India flocked to medical centres round the country. A well-known filmstar's brother took his daughter to the civic clinic for OPV as against that of a private practitioner. And, although slighted by the behaviour of the volunteers at the vaccine centre, A. S. Raju did travel all the way from Thirupathi to Bangalore by bus to get OPV for his child. The faith in the government mechanism this time round was complete.

As a result of the well-oiled operation of December 7, 1997, approximately 122 million children under five received the polio vaccine. The success of the campaign is clear in the downward trend nationwide since 1995 when this drive was initiated: from 4,791 reported cases of polio in 1994 to 682 cases in 1997 (till October 31).

In a country where 'political will' is a phrase much bandied but little served, where bureaucratic inefficiency is Augean, the resounding success of the drive is all the more impressive. It also shows that even the impossible can be done. How did the state machinery manage to get our millions to respond to the call this time, when past entreaties had fallen by the wayside?

According to UNICEF'S Indira Roy, the unrelenting creation of awareness was the key. "In Mumbai, we used our national ambassador Ravi Shastri to spread the message through visits and the electronic medium. We also roped in filmstars like Jackie Shroff, Sonali Bhendre and Shah Rukh Khan to shoot spots reminding people to administer OPV to children under three. We also prepared slides in regional languages with regional stars, which, incidentally, were telecast free of charge on all the satellite networks as well as Doordarshan." Not surprising then, a team of BMC workers was asked by a slum-dweller on D-day, "*Kya, aap Jackiewalla* dose *dene aaye hai?* Right across the length and breadth of the country, civic officials, medical students, school administrations joined the swell, trudging from door to door to educate the people, especially those living in the slums, about polio and the two-part immunization drive.

According to Dr Harsh Vardhan, health minister of Delhi — where the pilot project for the pulse polio drive was held in 1994 — it was all a matter of "mobilising the community and establishing a network". He explains, "I held over 1,000 meetings with government bodies, NGOs, teachers, *anganvadi* workers, the police etc as well as all the political parties. And, I personally visited the heads of all religious groups — Sikh, Hindu, Christian and Muslim. This helps creating awareness within these core groups which could be spread to the community at large."

To involve all strata of society, the BMC called on a meeting of representatives from various organisations as well as the corporate sector, the police and navy. Dr Ulhas Barve, officer on special duty (EPI) with the BMC recalls, "We identified over 250 to 300 persons and sent them invites signed personally by the executive health officer. And we got a stupendous response. Colgate-Palmolive helped us with stickers, HPCL/ BPCL put up banners at all its petrol pumps, Akbarally's and Shoppers' Stop allowed us to use their departmental store to spread awareness."

With the communication network in place, it was still a daunting task to set up an implementation process. In Delhi, as in 1995 and each following year, a central polio cell was established, and "we replicated the system followed during elections, dividing the city into constituencies, each of which had three doctors. At this level, the local cell manages all the peripheral activities, like co-ordinating with the gurdwaras etc," says Vardhan. "A huge volunteer force, drawn from government and NGOs aided doctors."

In Mumbai, the regular 6,716 centres set up for polio control that managed the action. "We have 176 health posts in the 23 wards of the city, each with a team of health officer and medical workers," points out Dr Barve. This team, along with UNICEF and Rotary officials, took charge of the operations on December 7, 1997. Girish Patel, who took his child to St Anne's School in Bandra for OPV, returned impressed with the efficiency and alertness of by the staff: "A vial fell to the ground while a medical worker was attending to my son; his colleague promptly told him to pick it up and discard it as a safety precaution."

On December 7, 1997, the Pulse Polio Drive in Mumbai recorded 100.29 per cent success. "The over-the-top figure is explained by the presence of the migrant population which came to the centres," points out Barve. "The floating population needs to be covered better," warns Dr B. J. Mahendra of Karnataka Institute of Medical Science, underlining the fear that the migrant population may be the critical factor in the dream of polio eradication by A.D. 2000. ■

(*With inputs from* **Sumita Paul** in Delhi and **Sriranjan Chaudhuri** in Bangalore)

THE BIG PICTURE

STURDY STATS

National Pulse Polio campaign started in: 1995

Number of reported Polio cases in 1994: 4,791

Number of reported Polio cases in 1997: 682

Number of children under five who received the polio vaccine on December 7: 122 million (apprx)

Number of health workers involved: two million

Number of immunisation posts set up across the country: 6,50,000

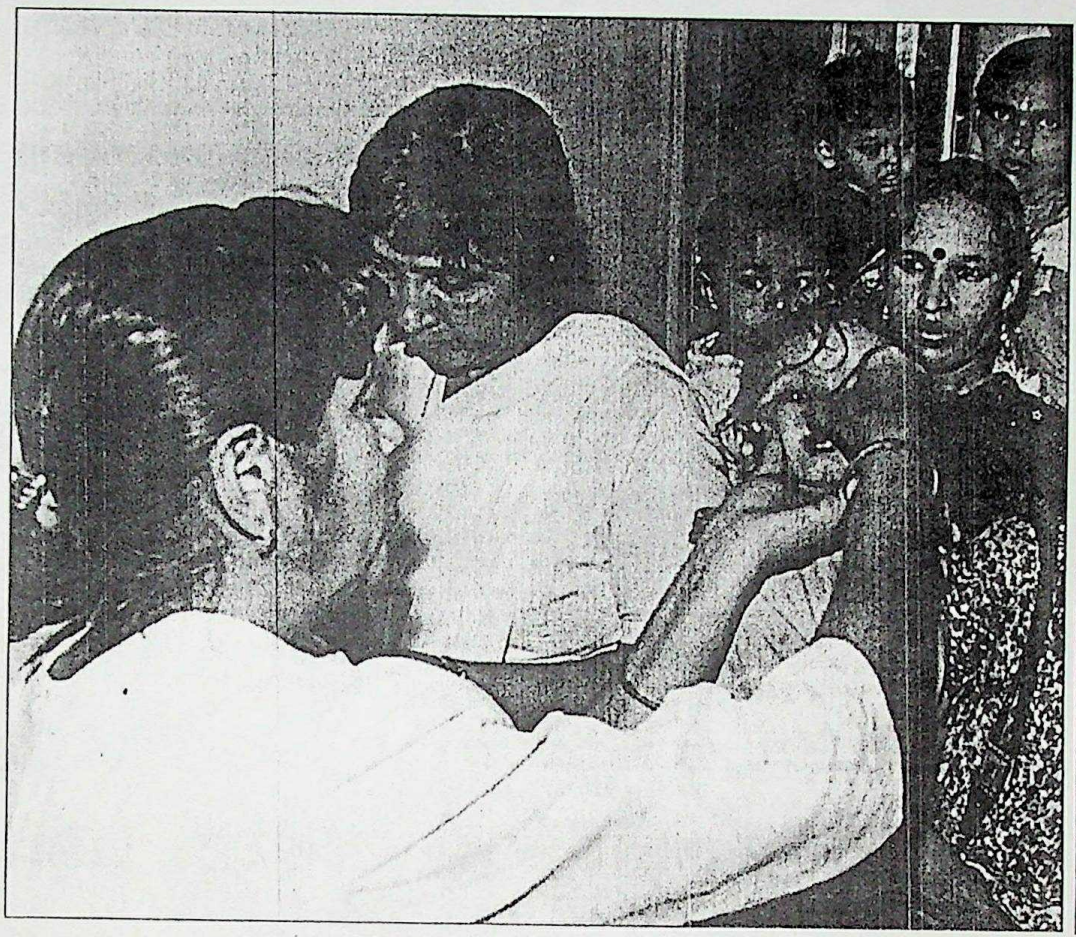
Projected cost of the 1997-'98 immunisation exercise (on both December 7, 1997, and January 18, 1998): Rs 214.6 crore.

D70C

CHC
DIS · 6.4

Polio-free India: Not far f

India began the polio eradication programme late, but statistics show that it has achieved a remarkable success rate. **Turja Sen** reports



Administering the oral polio vaccine and (right) a polio-stricken child

YOU simply cannot miss it. Hoardings all over, messages on buses and awareness campaigns on television.

The pulse polio eradication programme for 1997 which started yesterday is one of the largest health campaigns undertaken in the country. More than 6.5 lakh booths have been set up all over the country. A total of 26 lakh people will be involved in administering the oral polio doses. More than 117 million children were expected to have received the polio drops yesterday while more than 127 million children will be given the polio dosage on 18 January.

India may have started late on the eradication programme but if statistics are anything to go by, it is set to become a much awaited success story.

The figures have been encouraging after the adoption of the ambitious project for immunisation was undertaken. According to available figures, in the pre-1987 phase, around 28,000 new polio cases were detected every year. In 1995, this figure had dropped to 4000. In 1996, the number of new polio patients had gone down to 1005. And though the exact figures for 1997 are not available, experts are optimistic that this number will come down to around 700.

The oral polio vaccine has been available in India since 1979 but it was only as late as in 1985, that the Universal Immunization Programme was established and implemented in India. As a result of UIP efforts, in 1989 nearly 150 million doses of OPV were distributed in India and over 18 million infants received three doses of the vaccine. That year national coverage levels of Oral Polio Vaccine (OPV) reached 75 per cent of the children below five years.

Polio was eradicated in a small country like Cuba and Hungary in the sixties itself. Brazil was also successful in ensuring polio was removed from the country in the 1981. Then why did it take so long for India to eradicate the disease?

Says a senior WHO official: "Infrastructure was not available to undertake such a mammoth programme because the popula-

adds that both Cuba and Hungary were communist states where mandatory immunisation was imposed to curb the disease.

Poliomyletis is a disease caused by a virus. The disease exists worldwide. In temperate climates as in Europe and North America it is seasonal. In India, the incidence increases during July to September, coinciding with the rainy season.

Man is the only reservoir of the virus and there is no intermediate host or vector involved. "The virus spreads from man to man", says Dr Kaushik Banerjee,

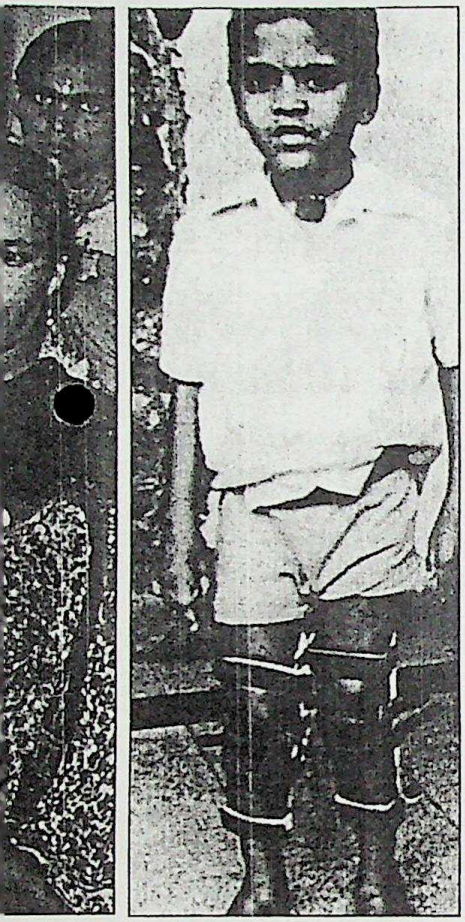
Trans

ACCORDING to a recent WHO report, scientists have recently succeeded in genetically engineering a mouse that is susceptible to polio. "Transgenic" mice will dramatically reduce the very high cost of polio vaccine quality control tests.

Since the polio virus exists

D 70C

ar from the dream



tricken child

Medical Officer of WHO which is actively involved in the eradication drive. "The virus mainly spreads through the faeces and the disease is therefore prevalent in areas where sanitation facilities are poor", he adds.

Once the virus gets entry into the body, it lodges itself in the intestines and the throat and multiplies inside. Once established, polio virus can enter the bloodstream and invade the central nervous system spreading along the nerve fibres. As it multiplies, the virus destroys the motor neurons. These motor neurons are responsible for activating the muscles. These nerve cells cannot be regenerated and the affected muscles no longer function. It results in acute flaccid paralysis.

In severe cases, which can prove to be fatal, polio virus attacks the motor neurons of the brain stem — reducing the breathing capacity of the patient and even causing difficulty in swallowing and speaking. This form of polio, which can also cause death, is known as the bulbar polio.

Two different kinds of polio vaccine are available.

An inactivated (killed) injectible polio vaccine was originally developed in 1955 by Jonas Salk, and a live attenuated weakened oral polio vaccine was later invented by Dr Albert Sabin in 1961.

There are distict difference between these two types of vaccines.

Dr Ashok Kapoor, a senior paediatrician at the Hindu Rao Hospital and one of the nodal officers of the polio immunization programme explains that an oral vaccine consists of "live" virus which have been made to lose its disease causing property. When it enters the body, it prevents the multiplication of the disease causing polio virus. "An essential characteristic of viruses is that a virus cannot proliferate in the presence of another virus", says Dr Kapoor.

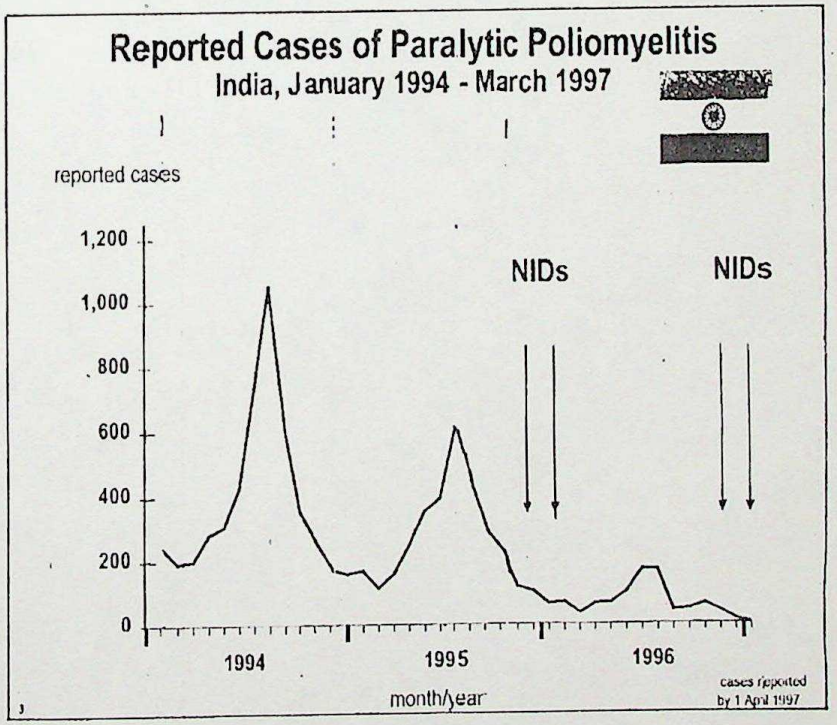
The virus contained in the vaccine is excreted by the children. And thus the mode of transmission of the polio virus is prevented because the polio causing virus present in the faeces is also prevented from multiplying.

"Since polio virus is mainly spread from the faecal matter, polio eradication through oral vaccine is prefered when polio has to be controlled among a big population", asserts Dr S K Mittal, National Coordinator of the immunization programme undertaken by the Indian Association of Paediatricians.

An added advantage of the OPV is being an oral vaccine, it does not have to be administered by a trained health worker.

According to WHO, the downside of the OPV is despite being mostly safe and effective, in extremely rare cases the live attenuated virus contained in the virus can cause paralysis. This figure is approximately one in every 2.5 million cases of doses administered.

On the other hand, the IVP which consists of dead or attenuated virus works by producing protective antibodies only in the blood — thus preventing the spread of poliovirus to the central nervous system and is more effective in ensuring personal immunity.



Transgenic mice

a recent
tists have
in geneti-

sible for scientists to carry out experiments on animals.

Until now, laboratories all

However, the new genetically engineered mice is susceptible to just one virus — the polio

Pulse polio campaign in troubled waters

SUMIT GHOSHAL
NOVEMBER 28

THE second round of the ambitious Pulse Polio Immunisation (PPI) programme scheduled on December 7 appears to have inspired none of the enthusiasm of last year, either among health officials or ordinary people.

Television spots featuring cine artistes and other celebrities to motivate people to bring their children to the vaccination booths, are expected to start appearing on Friday or Saturday, barely ten days before the big day. Last year, they had begun in the first week of October, fully two months in advance of the immunisation day.

Thousands of hand-bills and posters supposed to be put up at locations like bus stops and railway stations were under preparation till yesterday, according to sources in the civic health department. Hardly any have reached the public eye as yet.

The essence of the PPI campaign is that every child in the country below five years of age are to be given oral polio vaccine (OPV) on the same day. Thus, about 87 million children below three years were given OPV on December 9 last year and the dose was repeated on January 20. This year the number will be about 130 million, because the age limit has been increased from three to five years.

Thus public awareness is the key to the success of the campaign this year, particularly since people will want to know why the children vaccinated in the first round must receive the OPV again in the second round. Publicity, however, seems to be the weakest link in the preparations for this year.

Besides, the new Vaccine Vial Monitor (VVM) being introduced this year in about 20 per cent of the polio vaccine supplies is likely to add to the confusion among non-medical volunteers who will actually administer the vaccine to the kids.

The VVM consists of a square patch of light grey, surrounded on all four sides by another area which is dark grey in colour. It is placed on the vial to help the volunteer to confirm the potency of the vaccine, which may be consid

Continued on page 5

Pulse polio programme in troubled waters

Continued from page 1

erably reduced if the appropriate temperature is not maintained.

If the temperature of the vaccine happens to rise much above 4 degree Celsius for any length of time, its potency will be lost, in which case, both the patches on the Vaccine Vial Monitor will have the same shade of dark grey. It would then have to be rejected.

Moreover, the Oral Poilo Vaccine vials equipped with the Vaccine Vial Monitor, expected to come from Pasteur Merieux of France, have not reached the civic authorities till now.

"We have therefore issued a fresh circular today that the vaccine workers should go by the existing methods of assessing the quality of Oral Poilo Vaccine stocks," said Dr Alka Karande, executive health officer of BMC.

Dr Alka Karande said the health department had informed the state government depot in Mumbai and the UNICEF (United Nations Children's Fund) about the non-arrival of the French supplies of the oral polio vaccine.

The 20 lakh doses of polio vaccine received until now had come from the Haffkine Institute and were of the older variety, Dr Karande added.

The drive, the first phase of which is to take off over the next weekend and conclude with another one in January next year, is only the second in the series. Last year's inaugural drive had gone off well with few hiccups. ■

Specialists to evaluate pulse polio performance

D70C
H

10/12/97 M041

By Our Special Correspondent

NEW DELHI, Dec. 9.

Teams of public health specialists from 27 medical colleges would soon be fanning out into the field for an independent evaluation of the third round of the nation-wide pulse polio programme.

This was disclosed here today by Mr. Y. N. Chaturvedi, Secretary, Department of Family Welfare, in the Union Ministry of Health and Family Welfare.

The exercise, designed to detect any over-reporting on the performance of the programme, would be in the form of a survey. The specialists belonging to the preventive and social medicine departments would visit households and check whether their children had been administered the oral polio drops or not.

The exercise assumes importance, since as many as 26 lakh personnel are involved in the programme and even a slight error in reporting could produce a distored picture. Last year, reports from the States had initially indicated that every child in the target age group of under five, had been covered. An independent evaluation, however, revealed that the coverage was lesser, at 93 per cent.

This time too, preliminary reports indicate that all children under the age of five had been administered the vaccine on Sunday, when the first phase of the programme was conducted.

So far, reports have come in from 259 districts out of 528 and they speak of a coverage of two per cent over and above the target population — the excess being accounted for by children above the age of five, who might have been taken to the immunisation booths.

Mr. Chaturvedi also announced that from next year all the vials of the vaccines would carry special potency monitors. Now, only those vaccines which were imported had the monitors, which were in the form of labels that changed colour if the vials were not stored under proper conditions. They were not used for indigenously manufactured vaccines till now on the grounds that it would add another Rs. 20 crores to the cost of the programme. Now, the extra expenditure has been cleared.

The fixing of the monitors is expected not only to help in reducing the problem of wastage of vaccine, but also reduce the problems encountered in the testing of their potency.

THE HINDU
(MADRAS)
- 5 DEC 1997

Health Ministry's plea to EC on pulse polio

By Our Special Correspondent

NEW DELHI, Dec. 4.

The Union Ministry of Health and Family Welfare is approaching the Election Commission to ensure that the coming Parliamentary elections did not in any way affect the second leg of the pulse polio immunisation programme, scheduled for January 18.

The Ministry officials are to point out that a section of the Government functionaries, who would be involved in poll-related works, would be required for the nation-wide immunisation programme also. Besides, political workers at the field-level had a large role to play in mobilising the community and bring children to the immunisation booths.

According to the officials, it would be best if there could be a gap of one month between the day of immunisation and the election date, since activities relating to poll preparations would be spread over about a month.

The Ministry is gearing itself for the first leg of the third round of the pulse polio programme, scheduled for Sunday, December 7.

In all, 26 lakh personnel are being involved in the massive nation-wide programme, which would cover all children under the age of five, who number 12.2 crores.

The programme is being conducted through 6.5 lakh immunisation posts and with the assistance of international agencies, such as the Rotary International, British ODA, DANIDA, CDC, Atlanta and UNICEF, and voluntary organisations within the country, in the form of vaccine doses as also financial aid for transportation and other purposes.

A significant feature of the pulse polio immunisation programme this year is that all the SAARC countries are also organising their national immunisation days simultaneously with India with a view to avoiding any chance of transmission of wild polio virus from one country to another.

Addressing a press conference here this evening, Ms. Renuka Chowdhury, emphasised that every child below the age of five must be immunised on the two days — December 7 and January 18, irrespective of whether it had received the polio drops before or not.

This, she said, was essential for the country to achieve the goal of polio eradication by the year 2,000 and join the ranks of the 150 countries that have already reached the polio-free status.

Following the two rounds of the pulse polio immunisation programme in 1995-96 and 1996-97, India has already been able to achieve substantial reduction in the incidence of polio. As against 3,263 cases reported in 1995, only 1,005 cases were reported last year. This year, the total number of cases was expected to come down further to about 500.

Mr. Y. N. Chaturvedi, Secretary, Department of Family Welfare, said that following the success of the pulse polio programme, the Government was considering to launch similar programmes against measles and neo-natal tetanus also.

Indian J Pediatr 1994; 61 : 167-172

Acute Paralytic Poliomyelitis in Delhi (1975-1992)

J. Bhattacharjee, Devadethan and R.S. Sharma

National Institute of Communicable Diseases, Delhi

Abstract. Incidence of poliomyelitis in Delhi between 1975 and 1992, estimated from available data, shows a ladder-pattern type of decline from 15.65 in 1975 to 5.90 in 1992. The linear regression analysis shows a declining trend of incidence by 66.28% during the period. Huge increase of population with fast growing slums and resettlement colonies in Delhi was attributed to be responsible for partly counteracting different poliomyelitis control/eradication activities. The population representativeness of estimated incidence showed constant improvement during 1980 to 1991.
(Indian J Pediatr 1994; 61 : 167-172)

Key words : *Poliomyelitis; Incidence; UIP era; Trend.*

India has committed to eradicate poliomyelitis from the country by 2000 AD., consequent upon W.H.O. goal of global eradication of the disease. The criteria for eradication, as developed by W.H.O., call for a situation when there will be no case of poliomyelitis due to wild virus in India, with OPV coverage of 80% or more, for three consecutive years[1] (starting from 1998). In India, the Expanded Programme of Immunization (EPI) launched during 1978 was boosted up as the Universal Immunization Programme (UIP) from 1985 and National Child Survival and Safe Motherhood Programme (CSSM) from 1992. The surveillance of poliomyelitis has been strengthened since 1989. Reports from different parts of the country show that, in some states there is a satisfactory decline in incidence of poliomyelitis in past years.[2]

Reprint requests : Dr. J. Bhattacharjee, Chief Medical Officer, Epidemiology Division, National Institute of Communicable Diseases, 22, Sham Nath Marg, Delhi-110 054.

The investigators analysed the status of poliomyelitis in Delhi from 1975 to 1992, and tried to examine the reliability of its surveillance data about their population representativeness. The indicator which could reflect the status truly and also encompasses all other facets (like OPV coverage, OPV potency and efficacy, age-shift of cases, proportion of cases with OPV3 etc.), is the incidence of poliomyelitis per 100,000 population per year (henceforth will be called incidence). The present study, therefore, was limited to the estimation, analysis, comparison and interpretation of the incidence of the disease. The main idea behind the study was to try and use the available data in the best possible way to arrive at rational conclusions.

Material and Methods

Census population of Delhi during 1971, 1981, 1991 were used[3-5] to estimate the population of Delhi from 1975 to 1992, for rest of the years, by using exponential

growth. These were taken as denominators. Data on acute paralytic poliomyelitis (henceforth will be called poliomyelitis) cases among Delhi residents admitted in Kalawati Saran Children's Hospital (KSCH) Delhi, during 1975 to 1992 (data of 1989 was not available) and those of 12 reporting hospitals (including KSCH) from 1989 to 1991 (data for 1992 are unpublished) were collected.[6-9] It was found that on a average, 76.4% of Delhi resident cases in 12 hospitals were contributed by KSCH during 1990 to 1992. Thus the increment factor of 1.309 (100/76.4) was applied to estimate the Delhi resident cases from all supposedly reporting hospitals (12 being the approximate total number), during 1975 to 1988. These cases were taken as numerators and incidence of the disease was estimated for the period from 1975 to 1992. The trend of the disease during that period was plotted with the help of computer soft-ware Harvard Graphics, and using data from linear regression analysis ($Y = a + bX$, where constant "a" = 18.025, the regression co-efficient "b" = - 0.6764 and $SD_{reg.} = 2.23$).

Data on prevalence of poliomyelitis per 1000 underfive children in Delhi, as found in four lameness surveys conducted between 1981 and 1992, were collected and incidence of the disease was calculated with the help of multiplication factor 3.98 [(1.33 × 1.25 × 0.1198/5 × 100], where the estimated proportion of underfive in the population[10] was 0.1198. The incidence was taken as that of one year prior to the respective year of study. These were then compared, in trends with that of estimated incidence for the period from 1980 to 1991.

Results

Table 1 shows the estimated incidence of poliomyelitis among Delhi residents from 1975 to 1992. The boldly printed data are observed ones and rest indicate estimated figures.

The intervention activities against poliomyelitis initiated in Delhi during 19 to 1992 included launching of EPI in 19 UIP in 1985-86, strengthening of surveillance in 1989 and launching of CSSM in 1992. It is event from Table 1 and figure 1 that, the incidence of poliomyeli was very high (annual average 15.1 during "pre-EPI era" of 1975 to 1978. In the next "EPI era" of 1979 to 1984 though the magnitude was still higher (annual average 14.01), some declining pattern was observed. The next "UIP era" betwe 1985 and 1988 showed more drop incidence (annual average 11.01), howe

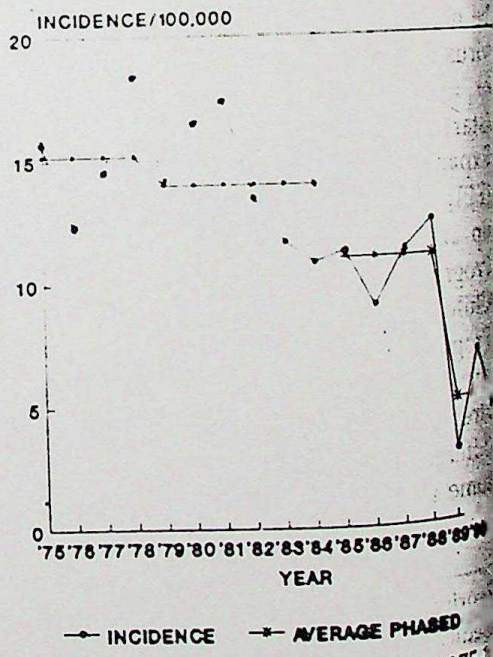


Fig. 1. Poliomyelitis in Delhi, 1975- Incidence and its ladder-pattern dr

TABLE 1. Estimated Incidence of Poliomyelitis in Delhi (1975 to 1992).

Years	Delhi cases in KSCH	Delhi cases in 12 reporting hospitals	Population of Delhi (100,000)	Incidence/ 100,000/ year	Annual average incidence
1971	–	–	40.66	–	
1975	576	754	48.19	15.65	
1976	469	614	50.28	12.21	
1977	581	761	52.47	14.50	15.19
1978	769	1007	54.74	18.40	
1979	617	808	57.12	14.15	
1980	749	980	59.60	16.44	
1981	829	1085	62.20	17.44	
1982	666	872	64.80	13.46	14.01
1983	604	791	67.51	11.72	
1984	583	763	70.33	10.85	
1985	633	829	73.27	11.31	
1986	524	686	76.33	8.99	11.01
1987	685	897	79.52	11.28	
1988	788	1031	82.85	12.44	
1989	Not available	242	86.31	2.86	
1990	464	616	89.92	6.85	
1991	311	406	93.70	4.33	4.98
1992	446	576	97.62	5.90	

without any steady decline. In the last "post UIP era" of 1989 to 1992, the incidence went down substantially with annual average of 4.98 i.e., less than half of the previous era but, again not showing any steady decline. On the whole, a ladder pattern type of declining incidence was prevailing in Delhi.

A declining trend in the incidence of poliomyelitis in Delhi from 17.35 in 1975 to 5.85 in 1992 is shown in Figure 2. The total drop during the period was 66.28%.

Incidence of poliomyelitis in Delhi calculated from the results of different lameness surveys[11-14] conducted between 1981 and 1992 are shown in Table 2 and shows a definite declining pattern. When these were compared with the estimated incidence of poliomyelitis between 1980 and 1991 in trend (Figure 3), a gradual improvement in the population representativeness of estimated incidence had been observed. Though the lameness survey figures were of higher magnitude than those of estimated, the gap in incidence between the two gradually narrowed down from 1.90 in 1980 to 0.71 in 1991.

DISCUSSION

The incidence of poliomyelitis in Delhi had decreased from 15.65 in 1975 to 5.90 in 1992. The decline during these 17 years

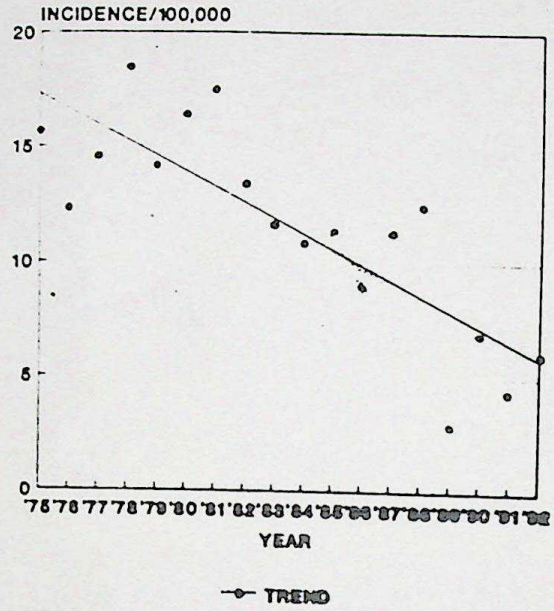


Fig. 2. Trend in poliomyelitis incidence. As per linear regression. Delhi : 1975 to 1992.

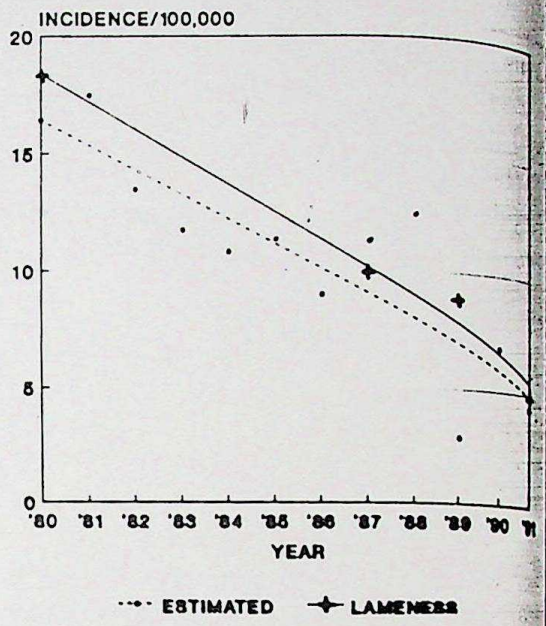


Fig. 3. Poliomyelitis in Delhi. Comparison of incidence trends. Estimated vs lameness (1980-1991).

was, however, of a ladder-pattern type, spreading over four intervention areas, as shown by average phased drop of incidence in Figure 1. Though the total drop in incidence reflects the cumulative effects of all the intervention activities, other demographic and environmental changes, the best achievement has been observed during 1989 onwards. The low incidence (8.99) during 1986 was probably due to the first impact of UIP, which was launched in Delhi during 1985-86 and the lowest incidence (2.86) during 1989 was probably the result of providing two additional doses of OPV, during early 1989 to all underfive children of trans-Yamuna area Delhi, which had been contributing maximum proportion of resident cases, as well as the

Table 2. Calculated Incidence of Poliomyelitis in Delhi, as per Lameness Surveys

Year of survey	Lameness prevalence/1000 < 5 children	Place of survey	Estimated incidence/ 100,000 population	Incidence projected for year
1981	4.60	Delhi	18.31	1980
1988	2.50	Delhi	9.95	1987
1990	2.23	Resettlement colony	8.87	1989
1992	1.22	South Shahadra	4.85	1991

temporary improvement in environmental sanitary conditions of that area after cholera epidemic of 1988.

The trend of incidence showed a decrease of 66.28% during the period under study (Figure 2). In Bombay, the incidence of poliomyelitis during 1987, 1990 and 1991 was found to be 14.00, 4.20 and 2.00 respectively.[2] In Delhi, though the incidence was low (11.28) in 1987, it was comparatively higher in 1990 and 1991 (6.85 & 4.33). Data on incidence of poliomyelitis from Haryana, Karanataka, Maharashtra, Pondicherry and some other states during 1980, 1985, 1990 and 1991 also showed much better situation than Delhi.

Delhi has made definite progress towards controlling the problem of poliomyelitis. There were periodic thrusts from successive intervention activities. The huge increase of population, particularly, in past two decades[16] (1971-1991) had resulted in many fast-growing slums and resettlement colonies in Delhi. That probably had overburdened the immunisation activities, as well as, the other civic amenities at different periods.

The comparison of poliomyelitis incidence between those estimated from surveillance data and calculated from lameness surveys, during 1980 to 1991, shows a clear improvement of surveillance over the years, which is a great achievement on the part of poliomyelitis eradication programme.

References

1. *Manual for Immunization Programme. Managers on Activities Related to Polio Eradication,* WHO/EPI/POLIO/89.1, March 1989.
2. Sokhey J. Poliomyelitis surveillance in India. *Indian Pediatr* 1992; 29 : 677-682.
3. *Health Statistics of India,* CBHI, DGHS, New-Delhi, 1971-75.
4. *Health Statistics of India,* CBHI, DGHS, New-Delhi, 1990.
5. *Health Information of India,* CBHI, DGHS, New-Delhi, 1991.
6. *The Expanded Programme on Immunization in South-East Asia,* SEARO Regional Health Paper No. 12, WHO, New-Delhi, 1986.
7. Panag P et al. *Acute Paralytic Poliomyelitis in Delhi (1978-1988),* Faculty of Department of PSM, Lady Hardinge Medical College, Faculty of Department of Pediatrics, Kalawati Saran Childrens Hospital, New-Delhi.
8. Panag P et al. *Acute Paralytic Poliomyelitis in Delhi 1990,* Faculty of Department of PSM, Lady Hardinge Medical College, Faculty of Department of Pediatrics, Kalawati Saran Childrens Hospital, New-Delhi.
9. Panag P et al. *Acute Paralytic Poliomyelitis in Delhi 1991,* Faculty of Department of PSM, Lady Hardinge Medical College, Faculty of Department of Pediatrics, Kalawati Saran Childrens Hospital, New-Delhi.
10. *Census of India. Social & Cultural Tables* Delhi, Registrar General of India, 1981.
11. Basu RN. Magnitude of problem of poliomyelitis in India. *Indian Pediatr* 1981; 18 (8) : 507-511.
12. *Combined Survey on ARI, Diarrhea and EPI,* National Institute of Communicable Diseases, Delhi, 1988.
13. Project Report. *Vaccination Coverage of Infants & Mothers, Prevalence of Poliomyelitis and Incidence of Neonatal Tetanus in Resettlement and JJ Colonies of Delhi,* Department of PSM, Lady Hardinge Medical College, New-Delhi, 1990.
14. Project Report. *Vaccination Coverage of Infants & Mothers, Prevalence of*

Poliomyelitis and Incidence of Neonatal Tetanus in North and South Shahadra (Delhi), Deptt of PSM, Lady Hardinge Medical College, New-Delhi, 1990.
15. Sokhey J. Progress of poliomyelitis control in selected states and union territories. *Indian J Com Med* 1992; XVII (4) : 140-150.
16. *Census of India, Series 1, Paper 2 of 1991, Provisional Population Totals*, Registrar General and Census Commissioner of India, August, 1991 : 39.

REVERSAL OF DEVELOPMENTAL DELAYS IN IRON DEFICIENT ANAEMIC INFANTS TREATED WITH IRON

Iron deficient anaemic infants perform worse in tests of mental and motor development than do iron-sufficient infants of similar age, However due to limitations in research design of previous studies there was no conclusive evidence that IDA causes the low developmental scores. The authors conducted a randomised, double-blind trial to monitor the effects of iron supplementation on performance in the Bayler scales of mental and motor development among 12-18-month-old infants in Indonesia.

Iron-deficient anaemic infants (n = 50) were assigned randomly to receive dietary ferrous sulphate or placebo for 4 months. Similar treatment randomisation was 'nono among nonanaemic iron-deficient (n = 29), and iron-sufficient (n = 47) infants, Before intervention, the mean mental and motor scores of the iron-deficient anaemic infants were significantly ($p < 0.01$) lower than those of the nonanemic iron-deficient and iron-sufficient classes. After intervention, developmental delays were reversed among iron-deficient anaemic infants who had received iron but they remained the same among placebo-treated iron-deficient anaemic infants.

The poor performance of 12-18-month-old iron-deficient anaemic infants in the Bayler scales of mental and motor development can be improved to the level of performance of iron-sufficient infants by treatment with ferrous sulphate.

Abstracted From
Idjradinate P, Pollitt E. *Lancet* 1993; 341 : 1-4

REFERENCES

1. Kazura JW. Cutaneous larva migrans. *In:* Nelson Text Book of Pediatrics, 14th edn. Eds Behrman RE, Kleigman RM, Nelson WE, Vaughan III VC. Philadelphia, WB Saunders Co, 1992, p 901.
2. Rudolf AM, Barnett HL, Einhorm AH. Helminthic diseases. *In:* Pediatrics, 16th edn. Eds Rudolf AM, Barnett HL, Einhorm AH. New York, Appleton-Century-Crofts, 1977, p 622.
3. Chatterjee KD. Parasitology, 12th edn. Calcutta, Chatterjee Medical Publishers, 1980, p 174.
4. Wittner M. *In:* Pediatrics, 18th edn. Eds Rudolf AM, Hoffman JIE, Axelrod S. Norwalk, Connecticut, Appleton and Lange, 1987, pp 645-646.
5. Leicht SS, Youngerg GA. Cutaneous larva migrans. Am Fam Physician 1987, 35: 163-168.
6. Rubio S, Ruiz L, Gascon J, Corachan M. Cutaneous larva migrans in travellers. Med Clin (BARC) 1992, 98: 224-226.
7. Toires JR, Orihisela AR, Garcia D, Abdul-Hadi S. Treatment of cutaneous larva migrans with albendazole: Preliminary report. Rev Inst Med Trop Sao Paulo 1989, 31: 56-58.
8. Louis FJ, DeQuincenet G, Louis JP. Value of single-dose invermecitin in the treatment of cutaneous larva migrans syndrome. Presse Med 1992, 21: 1483.

An Outbreak of Poliomyelitis in the Marathwada Region of Maharashtra State: 1990

V.B. Mandke
R.M. Pawar
D.D. Naik
S.D. Salgaonkar

Paralytic poliomyelitis continues to be a public health problem in India. Lack of high and sustained immunization coverage in the susceptible population leads to increased endemicity or periodic outbreaks.

One such outbreak in the Marathwada region (comprising 7 districts) of Maharashtra state in June 1990 was investigated by the Enterovirus Research Centre, Bombay. This was the second outbreak in this region since 1986(1). Epidemiological observations from the investigation are presented here.

Material and Methods

During the field investigations, detailed district-wise data of the outbreak, and data from the preceding 4 years as reported by the District Health Officers to the Deputy Director of Health Services, Aurangabad were obtained.

Stool samples were obtained from 52,

From the Enterovirus Research Centre, Indian Council of Medical Research, Bombay.

Reprint requests: Dr. V.B. Mandke, Assistant Director, Enterovirus Research Centre (ICMR), Haffkine Compound, Parel, Bombay 400 012.

Received for publication: August 17, 1993; Accepted: March 3, 1994

and blood samples from 39, clinically diagnosed cases of poliomyelitis in the acute/early convalescent phase of illness.

Viruses from stool samples were isolated on HEp2 cells grown in milk dilution bottles. The identification of viruses was carried out by microtiter neutralization technique using HEp2 cells(2). Sera were tested for neutralizing antibodies to polioviruses on HEp2 cells using microtiter technique(2). One hundred Tissue Culture Infective Dose of the specific attenuated viruses were used in the serum neutralization test.

Results

In the 10 month period from January to October 1990, 355 cases of poliomyelitis were recorded of which 300 cases (84.5%) were recorded in June and July. The overall incidence/100,000 population for the region in the 10 month period was 3.1. Although the outbreak involved all 7 districts, the extent of morbidity varied from district to district (*Table I*).

The details of age-wise distribution of 355 cases are given in *Table II*. It was observed that in 6 out of 7 districts the proportion of cases below 1 year of age was less than that between 1 to 2 years (*Table I*).

One hundred thirty nine children (39.1%) were unimmunized, 108 (30.4%) were inadequately immunized and 84 (23.7%) were fully immunized with 3 doses of OPV. Immunization status of 24 children (6.8%) was unknown. Among the 112 infants, 55 (49.1%) were unimmunized, 41 (36.6%) were inadequately immunized, 10 (8.9%) were fully immunized and in 6 (5.4%), the immunization status was unknown.

In the 52 stool specimen, poliovirus type 1 was isolated from 23 cases (44.2%), poliovirus type 2 from 1 case (1.9%), poliovirus type 3 from 1 case (1.9%), and "non-polio" enteroviruses from 7 cases (13.5%); 20 (38.5%) cases were "negative" for virus isolation. The geometric mean of the neutralizing antibody titer for poliovirus types 1, 2 and 3 of 38 sera was 130.35, 8.76, and 4.54, respectively.

TABLE I—*District-Wise Incidence and Proportion of Cases of Poliomyelitis Below 2 Years of Age in the Marathwada Region: 1990*

District	Number of cases	Incidence*	Proportion of cases(%)	
			Upto 1 yr	>1-2 yr
Aurangabad	55	2.9	23.6	41.8
Beed	59	3.8	27.1	55.9
Jalna	45	3.8	37.7	42.2
Latur	79	5.6	32.9	45.7
Nanded	27	1.3	33.3	37.0
Osmanabad	23	1.9	8.7	56.5
Parbhani	67	3.4	43.2	41.7

* Per 100,000 population.

TABLE II—*Age-Wise Distribution of Cases of Poliomyelitis in the Marathwada Region : 1990*

Age group (mo)	Number of cases	Percentage
0- 3	3	0.8
4- 6	16	4.5
7-12	93	26.2
13-18	79	22.3
19-24	83	23.4
25-30	12	3.4
31-36	35	9.8
37-48	18	5.1
49-60	11	3.1
>60	5	1.4
Total	355	100.0

Discussion

Large outbreaks of an infectious disease are usually followed by a period of low morbidity, mainly due to the "consumption" and the subsequent "building up" of susceptible individuals. After experiencing a large outbreak in 1986(1), the region of Marathwada expectedly went through a 3 year period of low morbidity before the outbreak in 1990.

However, some distinct qualitative differences were observed between the two outbreaks. The magnitude of morbidity was markedly less (355 cases and an incidence of 3.1/100,00 population in 1990; 1092 cases and incidence of 9.8 in 1986).

Infants accounted for 31.5% of the cases in 1990 and 43% in 1986(1). The relative higher proportion of cases in older children in 1990 suggest a subtle age shift associated with improving immunization coverage. Such a shift has also been observed in Bombay, where the immunization coverage has improved in recent years(3).

The immunization status (against poliomyelitis) of cases, in the two outbreaks was also markedly different with 55.3% unimmunized 27.7% inadequately immunized, and 17% fully immunized in the 1986 outbreak(1).

The lower magnitude of morbidity, lower proportion of cases in infants, and lower proportion of unimmunized cases in 1990, indicate an improved immunization coverage. However, the observation that among the infants 49.1% were not immunized and 36.6% inadequately immunized, suggests that the level of immunization coverage is not yet high enough to prevent outbreaks.

Poliovirus type 1 predominated in this outbreak. This was corroborated by antibody pattern. Poliovirus type 1 is known for greater morbidity in India and elsewere(1,3-5,6) and it also caused the previous outbreak in 1986(1). "Non-polio" viruses have been incriminated in polio-like illness(7). Their role in the etiology of polio-like illness needs to be critically ascertained as they are likely to gain importance as poliomyelitis gets controlled(7).

The main factor in the outbreak was failure to vaccinate or to complete the schedule of 3 doses of oral polio vaccine in a large number of children rather than vaccine failure. To avert such outbreaks in future the immunization coverage levels need to be rapidly brought up and sustained at atleast 85%.

Acknowledgement

The authors wish to thank Dr. G.A. Panse, the then Additional Director of

Health Services, Government of Maharashtra and Dr. J.T. Kale, the then Deputy Director of Health Services, Aurangabad for their immense help to our team in carrying out the field investigations.

REFERENCES

1. Mandke VB, Dave KH, Dama BM, Bansal MP, Patankar. Poliomyelitis in Marathwada region of Maharashtra state. Virus Information Exchange Newsletter 1986, 3:3.
2. Melnick JL, Herbert A, Wenner, Allan Phillips C. Enteroviruses. *In:* Diagnostic Procedures for Viral, Rickettsial and Chlamydial Infections. Eds Lennett EH, Schmidt NS. American Public Health Association Inc, 1979, p 471.
3. Annual Report of the Enterovirus Research Centre, (ICMR), Bombay, 1989.
4. Lee LH, Lim KA, Tye CY. Prevention of poliomyelitis in Singapore by live vaccine. Br Med J 1964, 1: 1077.
5. Arora RR, Chaudhari DS, Gujral VV, *et al.* Epidemiology of poliomyelitis in Delhi. Indian J Med Res 1978, 67: 11.
6. Sharma M, Sen S, Ahuja B, Dhamija K. Paralytic poliomyelitis 1976-1988: Report from a Sentinel Centre. Indian Pediatr 1990, 27: 143-150.
7. Dong De-Xiang. Immunization with oral polio vaccine in China. Prog Med Virology 1985, 31: 212-221.

Nutritional Status, Social Awareness and Attitude Towards Marriage of Adolescents in a Tribal ICDS Block of Himachal Pradesh

Lalita Bahl
R.K. Kaushal

Adolescence is an important phase of child growth and development. While persuing different child development services, the adolescent phase has generally been totally neglected. Healthy adolescents apart from developing into healthy adults and parents can also play a key role in social and health education of their younger siblings and uneducated parents. Since there is paucity of information in general(1) and none from Himachal Pradesh on rural adolescent children, the present study was undertaken to evaluate the nutritional and educational status, social awareness and attitudes towards marriage and child bearing in adolescents (11-18 years) of a tribal ICDS block.

From the Department of Pediatrics, I.G. Medical College, Shimla.

Reprint requests: Dr. (Mrs) Lalita Bahl, Professor and Head of Pediatrics, I.G. Medical College, Shimla (H.P.).

Received for publication: October 27, 1993; Accepted: March 9, 1994

Material and Methods

The three villages, Rispa, Namgia and Shilling situated at a height of 10,000 to 11,000 feet above sea level were surveyed by a team of doctors from Pediatrics Department, Indira Gandhi Medical College, Shimla in June, 1991. The sampling design, frame and methodology of the study

DIS-6.10

JOURNAL OF CLINICAL MICROBIOLOGY, Dec. 1995, p. 3252–3256
0095-1137/95/$04.00+0

Vol. 33, No. 12

Molecular Characterization of a Wild Poliovirus Type 3 Epidemic in The Netherlands (1992 and 1993)

MICK N. MULDERS,[1]* ANTON M. VAN LOON,[1] HARRIE G. A. M. VAN DER AVOORT,[1] JOHAN H. J. REIMERINK,[1] ALBERT RAS,[1] THEO M. BESTEBROER,[1] MICHAEL A. DREBOT,[2] OLEN M. KEW,[3] AND MARION P. G. KOOPMANS[1]

Laboratory of Virology, World Health Organization Collaborating Centre for Reference and Research on Poliomyelitis, National Institute of Public Health and the Environment (RIVM), Bilthoven, The Netherlands[1]; National Centre for Enteroviruses, Department of Microbiology, Victoria General Hospital, Halifax, Nova Scotia, Canada[2]; and Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia[3]

Received 13 March 1995/Returned for modification 5 June 1995/Accepted 29 September 1995

An outbreak of poliomyelitis due to wild poliovirus type 3 (PV3) occurred in an unvaccinated community in The Netherlands between September 1992 and February 1993. The outbreak involved 71 patients. The aim of this study was to characterize the virus at the molecular level and to analyze the molecular evolution of the epidemic virus. Molecular analysis was carried out by sequencing the VP1/2A junction region (150 nucleotides) of 50 PV3 strains isolated in association with this outbreak and the entire VP1 gene of 14 strains. In addition, the sequence of the VP1/2A junction region of strains from geographical regions endemic for PV3 (Egypt, India, and Central Asia) was analyzed and compared with the nucleotide sequence of the epidemic strain from The Netherlands. The earliest isolate was obtained from river water sampled 3 weeks before diagnosis of the first poliomyelitis patient and was found by VP1/2A sequence analysis to be genetically identical to the strain isolated from the first patient. Sequence divergence among the strains from the epidemic in The Netherlands was less than 2%. The closest genetic similarity (97.3%) was found with an Indian isolate (New Delhi, December 1991), indicating the likely source of the virus. A more than 99% sequence similarity was found in the VP1/2A region. Finally, the sequence information was used to design primers for the specific and highly sensitive molecular detection of PV3 strains during the epidemic.

Since 1988, the World Health Organization has been committed to the global eradication of poliomyelitis before the turn of this century (21). To realize this goal, two criteria have to be met: (i) no new cases of poliomyelitis due to wild poliovirus infection, and (ii) no more circulation of wild-type poliovirus in humans and in the environment. Improvement of vaccination coverage and surveillance of cases of acute flaccid paralysis, aided by virological laboratory analysis, are crucial elements of the eradication program. Since 1988, a substantial increase in vaccination coverage and a concomitant decrease in cases have been obtained (22). Nevertheless, epidemics continue to occur, even in countries with high vaccination coverage, such as The Netherlands. One of the reasons for this is the existence of communities with orthodox religious beliefs which refuse vaccination. As a result, members of these communities are at a continuous risk for the introduction of wild poliovirus. Epidemics in The Netherlands occurred throughout the 1960s; in 1971; in 1978, with 110 reported cases due to poliovirus type 1 (17); and again in the autumn of 1992, with 71 cases caused by wild poliovirus type 3 (14). None of the patients in these epidemics had been vaccinated.

Although conventional virological techniques are adequate to characterize a clinical isolate as vaccine derived or wild type, they are not suitable for establishing relationships among strains or to pinpoint the source of a virus. For these purposes, genomic analysis of a 150-nucleotide fragment encompassing the VP1/2A junction region has been used (15). Because poliovirus genomes have been reported to evolve rapidly upon passage through humans (1 to 2% nucleotide changes per year [13]), transmission pathways can be inferred from the patterns of nucleotide variation among strains. Genetic similarity of 98% or more is considered to imply a direct epidemiological link. Genotypes of poliovirus have empirically been defined as groups of strains that show at least 85% sequence similarity in the VP1/2A junction region (15). Molecular epidemiological findings are also used to study the progress of the eradication initiative and to identify reservoirs sustaining virus transmission (6).

In addition to sequence analysis of the VP1/2A junction region, analysis of larger regions of the genome, e.g., the entire 900-nucleotide major capsid protein gene VP1, may give additional information on the molecular evolution of the virus during an epidemic, e.g., clonal spread of the virus versus multiple lineages and antigenic drift (4), and on transmission mechanisms within an epidemic (6). Also, specific primers and probes for rapid molecular detection and characterization of the epidemic strain in clinical and environmental samples can be designed, which in turn provides an easy tool to monitor silent transmission of the epidemic virus.

In this report, we describe the molecular characterization of poliovirus strains isolated during the poliovirus type 3 epidemic in The Netherlands from 1992 to 1993. The possible source of importation and the intraepidemic sequence variation within the VP1/2A junction region and for the entire VP1 gene are presented. Moreover, results with primers designed f

* Corresponding author. Mailing address: Laboratory of Virology, National Institute of Public Health and the Environment (RIVM), P.O. Box 1, 3720 BA Bilthoven, The Netherlands. Phone: 31-30-2743944. Fax: 31-30-2744449. Electronic mail address: mulders@rivm.nl.

TABLE 1. Primers used in this study

Primer	Sequence[a]	Position[b]	Fragment (length in bp)[c]
M3s (B)	GTC AAT GAT CAC AA (C/T) CC[d]	3206–3222	a (290)
2A	AAG AGG TCT CTA TTC CAC AT[e]	3476–3495	
M1	tgt aaa acg acg gcc agt TTT GTG TCA GCG TGT AAT GA[f]	2399–2418	b (678)
M23	cag gaa aca gct atg acc TGC CAI GTG TA (A/G) TC (A/G) TCC	2980–2997	
M9	tgt aaa acg acg gcc agt TTC AC (C/A) TAI TCI AGN TTT GA[f]	2843–2862	b′ (643)
M6	cag gaa aca gct atg acc AAG AGG TCT CTA TTC CAC AT[e]	3476–3495	
NET1	CGC CAA ACC ATC CTT GTA	3232–3250	c (115)
NET2	TAC ATC AAA GGT GCG AAT C	3329–3347	

[a] The M-13 sequence is given in lowercase.
[b] The numbering is according to reference 18.
[c] The fragments are as described in the legend to Fig. 1.
[d] As published in reference 10.
[e] Published previously without the M-13 tail (15).
[f] Published previously without the M-13 tail (1).

specifically detect and characterize the epidemic virus are known.

(Part of this work was presented at the IXth International Congress of Virology, Glasgow, Scotland, 8 to 13 August 1993, and at the VIIIth Meeting of the European Study Group on the Molecular Biology of Picornaviruses ("Europic '94"), Korpilampi, Finland, 6 to 11 August 1994.)

MATERIALS AND METHODS

Background on the epidemic. After 14 years without endemic cases of poliomyelitis, an outbreak of wild poliovirus type 3 infections occurred in The Netherlands between September 1992, and February 1993 (14). A total of 71 cases of poliomyelitis were reported to the national public health authorities. As in previous outbreaks in 1971 and 1978, all cases, except one, occurred among members of a closely knit, orthodox religious denomination which rejects vaccination (14, 17). Likewise, the epidemic in 1992 and 1993 was confined to a distinct geographical area stretching from the southwest to the northeast of the country, where communities with a vaccination coverage rate well below 90% exist (14). Cases were virologically confirmed by wild-type poliovirus type 3 isolation from feces or throat swabs (90% of cases) and/or by detection of poliovirus type 3-specific immunoglobulin M antibodies by an enzyme immunoassay (91% of cases [12]).

Viruses. Fecal samples and throat swabs as well as concentrates of environmental specimens were examined by standard procedures for virus isolation, titration, and typing (14). Intratypic differentiation was carried out by an enzyme-linked immunosorbent assay that uses cross-absorbed rabbit antisera specific for vaccine-derived or wild-type polioviruses to establish their wild-type character (20). A total of 50 poliovirus isolates were characterized in the VP1/2A junction region: 48 were from cases that were reported throughout the epidemic and 2 were from environmental samples of river water obtained 3 weeks prior to diagnosis of the index patient (EnvA/NET92) and from sewage (EnvB/NET92) obtained 4 days after diagnosis of the index patient (19). Fourteen isolates from the cases had their entire VP1 gene sequenced. For validation of the reverse transcriptase-PCR (RT-PCR), we used strains that had been sent to the National Institute of Public Health and the Environment between 1977 and 1994 for virological characterization and intratypic differentiation.

Analysis of the VP1/2A junction region. Analysis of the VP1/2A junction region was carried out as described previously (10). Alternatively, a slightly modified primer, M3sB (5′-GTC AAT GAT CAC AAT CC-3′), was used instead of M3s when amplification efficiency was found to be low. Sequence analysis across the recognition sequence of primer M3s in poliovirus type 3 strains from The Netherlands revealed a mismatch at the third position from the 3′ end of this primer.

Analysis of the VP1-gene. (i) RNA isolation. For cDNA synthesis, RNA was purified from 100 μl of cell culture supernatant as described previously (23).

(ii) Primers. For sequence analysis of the VP1 gene, the region was amplified in two fragments with sizes of 678 bp (M1 and M23) and 634 bp (M9 and M6), with a 143-bp overlap (Table 1 and Fig. 1; fragments b and b′, respectively). Primers M1 and M6 have been published previously without the M13 tails as UG1 (1) and 2A (15), and they were used as primers for the amplification of all poliovirus genomes. Inner primers M9 and M23 were selected from regions in the VP1 gene that are conserved in the prototype reference strains (Table 1 and Fig. 1). To overcome possible primer mismatches due to the expected high level of sequence variation within this gene, either deoxyinosine or multiple nucleotides were incorporated at certain positions (third base wobble).

(iii) RT-PCR. Reverse transcription was carried out for the VP1/2A junction region as described previously (10), except that the $MgCl_2$ concentration was lowered to 1.5 mM. The PCR mixture was subjected to 40 cycles of denaturation at 94°C for 45 s, annealing at 42°C for 60 s, and extension at 60°C for 90 s. Analysis and purification of PCR products were carried out as described previously (10).

(iv) Sequence analysis of PCR products. PCR products were sequenced by dideoxy chain termination cycle sequencing with fluorescein-labeled M13 primers, and the sequencing was carried out according to the manufacturer's protocol (Applied Biosystems Inc., Foster City, Calif.). Sequences of the VP1/2A junction region and the entire VP1 gene were edited and aligned with SEQED (version 1.0.3; Applied Biosystems Inc.) and converted to the GENEWORKS format (Intelligenetics, Mountain View, Calif.). Genetic relationships were estimated on the basis of the 150-nucleotide VP1/2A junction region with phylogenetic trees generated by the UPGMA (unweighted pair group with arithmetic mean) method (11).

RT-PCR for the detection of poliovirus type 3 from The Netherlands. (NET-PCR). Primers for the PCR were selected from regions at the 3′ end of the VP1 gene (Fig. 1 [fragment c] and Table 1) that were sufficiently different from those of representative strains of the different genotypes. Forward primer NET1 is located within the immunodominant site 3a (9). Reverse primer NET2 is located at the most outer 3′ end of VP1. A single-tube RT-PCR was started by adding 1 μl of freeze-thawed, clarified virus supernatant to a premixture containing all the necessary reagents except the enzymes and incubating the mixture for 30 min at 65°C and for 5 min at 95°C in order to disrupt the virus particles and release the RNA. After the mixture was chilled on ice, the enzymes were added and reverse transcription directly followed by the PCR was carried out in 20 μl with the following constituents: 0.5 μM (each) primers NET1 and NET2, 1.0 mM (each) deoxynucleoside triphosphates, 50 mM Tris HCl (pH 8.8), 50 mM NaCl, 6 mM $MgCl_2$, 0.1 μg of bovine serum albumin (Boehringer Mannheim Biochemicals) per μl, 2.0 mM dithiothreitol (Merck, Darmstadt, Germany), 50 mU of avian myeloblastosis virus RT per μl, 64 mU of RNase inhibitor per μl, and 28 mU of *AmpliTaq* DNA polymerase per μl. The cycling program was 1 cycle at 42°C for 30 min and 1 cycle at 95°C for 5 min followed by 30 cycles of denaturation at 95°C for 1 min, annealing at 54°C for 1 min, and extension at 72°C for 2 min. The 115-bp PCR product was detected on an ethidium bromide-stained, 12% polyacrylamide gel (16). In order to evaluate the specificity and sensitivity of the PCR, we used a well-characterized panel containing 30 recent isolates

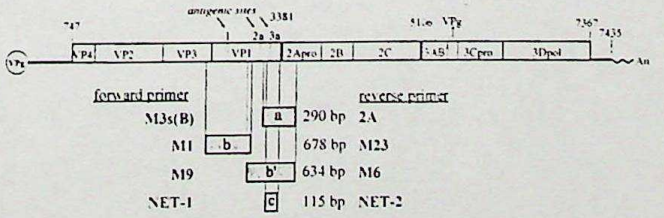


FIG. 1. Locations of the regions in the poliovirus genome that were amplified as described in Materials and Methods. Fragment a is a 290-bp fragment encompassing the 150-nucleotide VP1/2A junction region, fragments b and b′ are overlapping PCR products spanning the entire 900-nucleotide VP1 gene, and fragment c is a 115-bp region that is located at the 3′ end of VP1 and that was amplified by the PCR specific for the virus involved in the epidemic in The Netherlands.

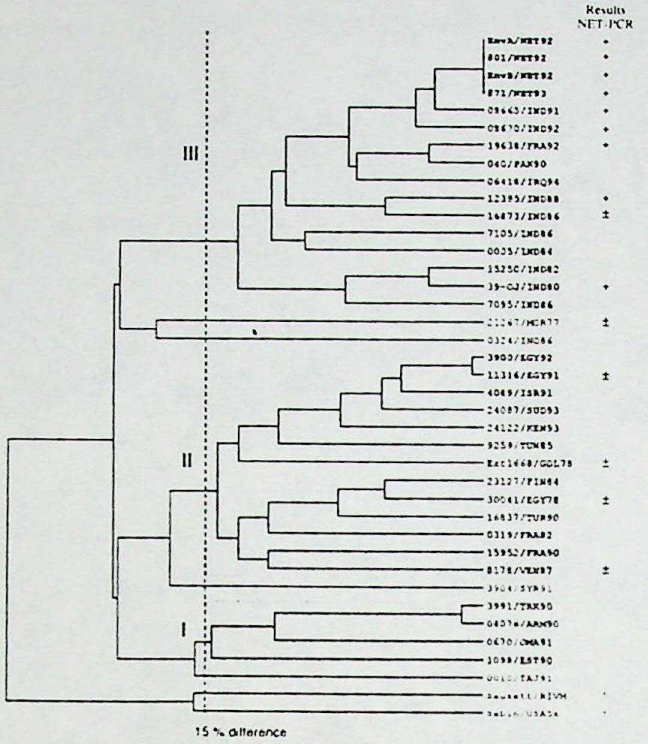


FIG. 2. Dendrogram based on the 150-nucleotide sequence of the VP1/2A junction region in the poliovirus type 3 genome (positions 3289 to 3438 [18]). Included are 4 strains isolated during the epidemic in The Netherlands during 1992 and 1993 (bold), 33 wild poliovirus type 3 strains isolated between 1977 and 1993 in different parts of the world, and the prototype strains used in the oral and inactivated poliovirus vaccines (Sabin/USA56 and Saukett/RIVM). The dotted line indicates 15% nucleotide variation and signifies a genotype (15), with a genotype being defined as a cluster of sequences of different strains with a sequence diversity of less than 15%. The three genotypes (I, II, and III) are shaded. The reactivity of the strains tested by the PCR (NET-PCR) are also given (+, positive; ±, weak positivity; −, negative). (Country abbreviations: ARM = Armenia, EGY = Egypt, EST = Estonia, FRA = France, FIN = Finland, GDL = Guadeloupe, IND = India, INO = Indonesia, IRQ = Iraq, ISR = Israel, KEN = Kenya, MOR = Morocco, NET = Netherlands, OMA = Oman, PAK = Pakistan, SUD = Sudan, SYR = Syria, TAJ = Tadjikistan, TRK = Turkmenistan, TUN = Tunisia, TUR = Turkey, USA = United States of America, VEN = Venezuela.)

from each poliovirus serotype from all over the world and the prototype strains used in vaccine production. In addition, we used 21 other enterovirus isolates.

RESULTS

Reproducibility of PCR sequence analysis. The reproducibility of the cycle-sequencing method was tested by comparing repeated sequencings of the VP1/2A junction region of independently obtained RT-PCR products at one virus passage level (five sequences) and at different passage levels (three sequences). The index case isolate was sequenced eight times at three different passages and at three different time points over a period of 18 months by two different individuals. All sequences were identical. Fourteen other strains isolated during the epidemic were sequenced twice from independently obtained amplicons. Only one strain showed a 1-nucleotide difference in the entire 253-bp interval between primers M3s(B) and 2A. The overlap between the VP1/2A junction region and the VP1 gene was also used to compare sequences obtained by different methods (dye-terminator and dye-primer protocols). A comparison of the sequences of the 154-bp overlapping region located at the 3′ end of VP1 for both fragments

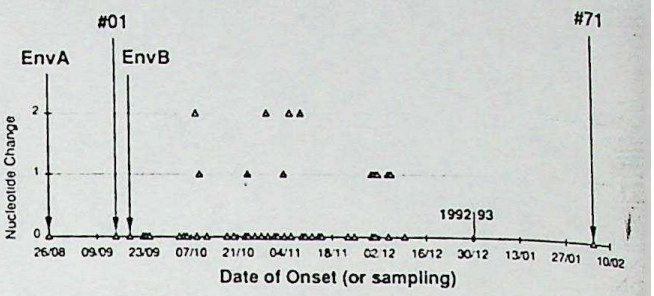


FIG. 3. Nucleotide sequence variation in the VP1/2A junction region for a total of 50 strains, as judged on the basis of the sequence of the first case isolate (#01). The number of nucleotide changes is shown; the horizontal axis shows the dates of the onset of illness for the case isolates and the dates of isolation for the other strains. Two environmental isolates (EnvA and EnvB [19]) have been included.

revealed some discrepancies, with an average difference of 1.76 nucleotides (1.1%; range, 0 to 4; standard deviation = 1.48; n = 18).

Source of the epidemic virus. We compared the sequence of the 150-nucleotide VP1/2A junction region in the genome of the index case isolate as well as those of 3 other strains related to the outbreak (the last case isolate, #71/NET93, and 2 environmental isolates, EnvA and EnvB [19]) with those of 33 wild poliovirus type 3 isolates and the 2 prototype vaccine strains (Sabin/USA56 and Saukett/RIVM). In the dendrogram, three distinct branches in addition to that of the vaccine strains can be seen (Fig. 2). Each branch represents one genotype (a more than 15% sequence difference [15]). The first main genotype (genotype I) is represented by four strains that were isolated in the Central Asian republics. Genotype II, represented by 13 isolates, is found mainly in the Mediterranean region and also includes the poliovirus type 3 strain from the Finland 1984 epidemic as well as 2 strains isolated in the Americas (8178/VEN87 and Ext1668 GDL78). The third main genotype (III) is represented by 18 strains and contains 6 isolates from the outbreak in The Netherlands. The closest similarity (146 of 150 nucleotides identical, 97.3%) to the VP1/2A sequence of the index case (#01/NET92) was found with a strain isolated in India in November 1991 (08665/IND91). Seven older strains from India (39-OJ/IND80, 15250/IND82, 0005/IND84, 16837/IND86, 7095/IND86, 7105/IND86, and 12395/IND88) also cluster in this genotype, illustrating that this genotype had been circulating in India in an endemic fashion at least since 1980. Another strain belonging to this genotype was isolated in France in 1992 (19638/FRA92). The VP1/2A nucleotide sequences of three other isolates taken during the epidemic in The Netherlands and shown in this dendrogram were identical to that of the index case isolate.

Intraepidemic sequence variation within the VP1/2A junction. To determine the molecular evolution of the RNA genome during the outbreak, the VP1/2A sequences of 48 strains from patients and 2 environmental isolates were compared with the sequence of the index case (Fig. 3). The maximum sequence variation was 2 nucleotides (<1.5%). Thirty-five strains isolated during all stages of the epidemic were identical to the index strain; nine strains had one nucleotide substitution in the VP1/2A junction and four strains had two nucleotide changes. Of the 17 nucleotide substitutions, 2 were transversions and 15 were transitions; 9 substitutions resulted in synonymous codon changes and 7 resulted in a different amino acid codon (three alanine-to-valine changes at position 275 in the VP1 gene, two serine-to-proline changes at position 293 in

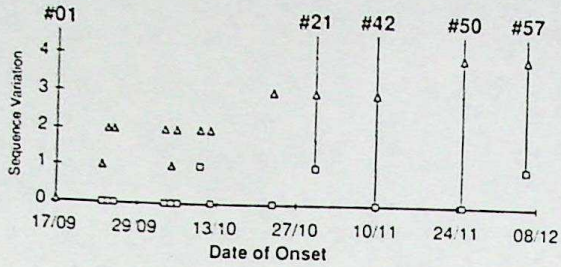


FIG. 4. Nucleotide (△) and amino acid (□) sequence variation for the entire 900 nucleotides of the VP1 gene of 13 strains isolated from patients (#21, #42, #50, and #57 as well as nine others) at different time points during the epidemic, as judged on the basis of the sequence of the first case isolate (#01). The vertical axis gives the amount of variation in nucleotides or amino acids; the horizontal axis gives the date of the onset of disease.

the VP1 gene, one tyrosine-to-phenylalanine change at position 10 in the 2A gene, and one threonine-to-alanine change at position 11 in the 2A gene). None of the amino acid codon changes were located in the antigenic site 3a (9).

Molecular evolution in the VP1 gene. The complete VP1 gene of 14 strains was sequenced and compared with that of the index case strain in order to further analyze the intraepidemic genomic variation; the strains had been isolated throughout the course of the epidemic (Fig. 4). A maximum sequence diversity of 4 nucleotides was found (<0.4%), resulting in a maximum amino acid sequence difference of 1 codon, located outside the antigenic sites.

NET-PCR. All strains isolated during the outbreak and tested by this assay gave the expected 115-bp product. Serotype 1 and 2 strains were all negative by this PCR assay, as were 21 nonpoliovirus enteroviruses (echovirus 24 gave a distinct but smaller fragment). Of the 33 type 3 panel strains, 8 were positive, although 3 strains (30041/78EGY, 11316/EGY91, and Ext1668/GDL78) were amplified only very poorly (data not shown). Sequence analysis of these eight strains revealed a high degree of similarity between the primer recognition sequences of these strains and that of the strain from the outbreak in The Netherlands (Fig. 5). In addition, three other strains not included in the panel (08665/IND91, 08570/IND92, and 19638/FRA92), were also positive by this assay. Six of the all 11 NET-PCR-positive poliovirus type 3 strains cluster in the same genotype (III): 5 of these strains were isolated between 1980 and 1992 in India (08665/IND91, 08670/IND92, 12395/IND88, 16873 IND86, and 39OJ/IND80) and 1 was isolated in France in the same year that the outbreak started (19638/FRA92). Four strains belong to genotype II (Fig. 5): 11316/EGY91, 8178/VEN87, 30041/EGY78, and Ext1668/GDL78. The remaining PCR-positive strain, strain 21267/MOR77, does not cluster in any of the genotypes.

The sensitivity of the NET-PCR for strains isolated during the epidemic in The Netherlands was compared with that for unrelated PCR-positive strains. Virus titers were determined for all strains, and serial 10-fold dilutions were tested by the PCR assay. The sensitivity of this test was defined as the amount of input virus that gave a visible PCR product on an ethidium bromide-stained agarose gel. Epidemic strain 16260/01/NET92 could be detected to a dilution of 10 50% tissue culture infective doses per RT-PCR reaction. The sensitivity of the PCR for the detection of strains 16873/IND86, 11316/EGY91, 8178/VEN87, 30041/EGY78, and 21267/MOR77 with two mismatches close to the 3′ end of primer NET1 (Fig. 5) was at least 1,000-fold less (data not shown).

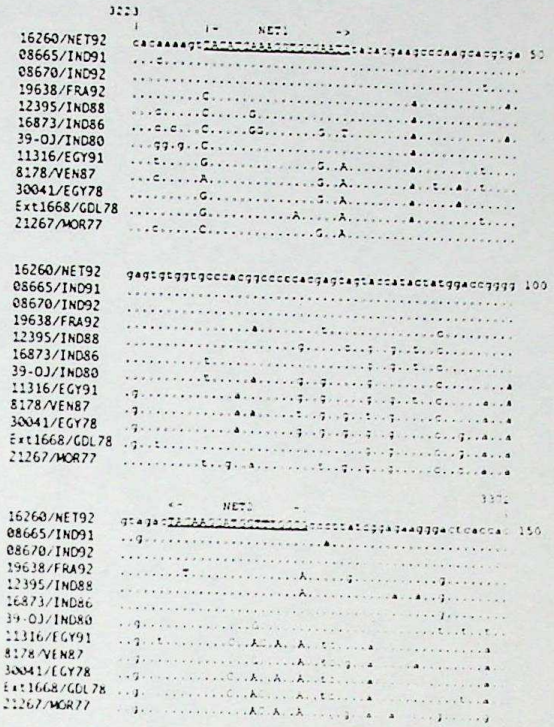


FIG. 5. Alignment of a 150-nucleotide region at the 3′ end of VP1 between positions 3223 and 3372 (18) and encompassing the recognition sequences (underlined, with the carets indicating direction) of the primers (NET1 and NET2) used in the NET-PCR with strains 08655 IND91, 08670 IND92, 19638 FRA92, 12395 IND88, 16873 IND86, 39-OJ IND80, 11316 EGY91, 8178 VEN87, 30041 EGY78, Ext1668 GDL78, and 21267 MOR77. The reference sequence (top) is from the poliovirus type 3 isolated from the index case in the epidemic in The Netherlands (16260/01 NET92); the other sequences are from nonepidemic strains that gave a product by the NET-PCR.

DISCUSSION

In this report, we describe the molecular analysis of poliovirus type 3 isolates from the epidemic in The Netherlands in 1992 and 1993.

Sequence analysis of the VP1/2A junction region of the first poliovirus type 3 strain (16260/01/NET92) involved in the outbreak in The Netherlands revealed a similarity of 97.3% with that of a poliovirus type 3 strain isolated in Bombay, India, in November 1991 (08665/IND91), indicating that the epidemic virus was imported from this region. Since poliovirus is endemic to India, it is probable that genetically even more related strains were circulating but not sampled. High sequence diversity among poliovirus type 1 strains in such regions of endemicity as India and also Egypt, Pakistan, and the Caucasian republics underscores this possibility (5, 8, 10).

Within the epidemic, sequence variation among isolates was minimal: 48 strains isolated from patients during this epidemic, 2 environmental isolates taken either 3 weeks before or during the outbreak, and 2 isolates from contacts in southern Alberta, Canada (2), showed a sequence variation in the VP1/2A junction region of less than 1.5%. This indicates the clonal spread of one variant during the epidemic, which was further confirmed by sequence analysis of the entire VP1 region of 14 strains. As poliovirus had not been endemic to The Netherlands during the 14 years preceding the epidemic in 1992 and 1993, the spread of one imported poliovirus variant in a susceptible, nonvaccinated, and closely knit population is not surprising.

To determine whether the observed sequence variation was real or reflected misincorporation during amplification, several strains were analyzed more than once. By each method (VP1/2A sequencing and VP1 sequencing), sequences were found to be identical with only one exception, showing the reproducibility of the automated RT-PCR sequencing method for these regions. Surprisingly, however, when sequences generated by the two different methods (dye-terminator sequencing of the VP1/2A junction and dye-primer sequencing of the VP1 gene) were compared, the sequence variation in the overlapping 154-bp region was found to be significant. These findings show the need for cautious interpretation when sequences obtained by different methods are compared. It is unclear what actually caused this discrepancy. Previously, we showed that sequence analysis of the VP1/2A junction by automated cycle sequencing (both dye-primer and dye-terminator protocols) and conventional radioactive sequencing with avian myeloblastosis virus RT resulted in identical sequences (10).

The lack of sequence variation is somewhat surprising, since the poliovirus type 3 strain responsible for an outbreak in Finland during 1984 showed significant variation in and around the antigenic sites among isolates obtained from different patients (3, 4). This discrepancy may be explained by the differences between the populations in which these outbreaks occurred: in Finland, the outbreak occurred in a vaccinated community with insufficient immunity to the infecting strain, whereas the outbreak in The Netherlands involved people who had never been vaccinated and therefore had no preexisting immunity to the infecting strain. Therefore, the poliovirus type 3 strain causing the outbreak in Finland was subject to some degree of immune selection, whereas the strain in The Netherlands was not.

To develop a rapid and easy test to detect and characterize the strain responsible for the outbreak in The Netherlands, specific PCR primers were designed. Using these primers, we were able to amplify all epidemic strains (sensitivity, 100%). However, the specificity of the assay was lower for some genetically more distant strains. These strains were also amplified, though at a 1,000-fold lower level of efficiency. Subsequent sequence analysis of these strains revealed mismatches in the last four nucleotides at the 3′ end of primer NET1; the possibility of successful amplification despite such mismatches has been described previously (7). Despite these shortcomings, the NET-PCR was a helpful, reliable, easy, and fast tool to confirm classic serological and intratypic characterization (19) and to monitor silent transmission (2) during the epidemic.

Close virologic monitoring of endemic and epidemic strains is critical for the eradication program. Such molecular epidemiological methods as that described in this study can be used to establish routes of transmission and to find problem areas with multiple cocirculating virus lineages. These areas should be specifically targeted by the global poliovirus eradication campaign.

ACKNOWLEDGMENTS

We thank Ria de Bruin (RIVM) for isolating the river water strain, Galina Lipskaya (Moscow State University) for generously providing the sequences of isolates from the former Soviet Union, and Anita Huovilainen (KTL, Helsinki) for sequencing the Pakistani isolate and for helpful discussions. Also, we thank David Wood (NIBSC, London) for sending the Indian isolates and Tary Naguib (Vacsera, Cairo) for sending the African isolates and Baldev Nottay, Su-Ju Yang, and Lina De (CDC) for sequencing some other isolates. Primers were synthesized at the CDC Biotechnology Core Facility (Brian Holloway, Edwin George, and Melissa Jamieson). Tapani Hovi (KTL, Helsinki) is acknowledged for helpful discussion.

M.N.M. was funded in part by the Praeventiefonds (grant 28-2325).

REFERENCES

1. **Balanant, J., S. Guillot, A. Candrea, F. Delpeyroux, and R. Crainic.** 1991. The natural genomic variability of poliovirus analysed by a restriction fragment length polymorphism assay. Virology 184:645–654.
2. **Drebot, M. A., M. N. Mulders, J. J. Campbell, O. M. Kew, and S. H. S. Lee.** The molecular detection of an importation of type 3 wild poliovirus into Canada from The Netherlands in 1993. Submitted for publication.
3. **Hovi, T.** 1989. The outbreak of poliomyelitis in Finland in 1984–1985: significance of antigenic variation of type 3 polioviruses and site specificity of antibody responses in antipolio immunizations. Adv. Virus Res. 37:243–275.
4. **Huovilainen, A., M. Ferguson, L. Kinnunen, and T. Hovi.** 1988. Antigenic variation among 173 strains of type 3 poliovirus isolated in Finland during the 1984 to 1985 outbreak. J. Gen. Virol. 69:1941–1948.
5. **Huovilainen, A., M. N. Mulders, M. Agboatwalla, T. Pöyry, M. Stenvik, and T. Hovi.** Genetic divergence of poliovirus strains circulating in Pakistan between 1989 and 1995. J. Gen. Virol., in press.
6. **Kew, O., L. De, C.-F. Yang, B. Nottay, E. da Silva, and M. Pallansch.** 1993. The role of virologic surveillance in the global initiative to eradicate poliomyelitis, p. 215–246. *In* E. Kurstak (ed.), Control of virus diseases, 2nd ed. Marcel Dekker, New York.
7. **Kwok, S., D. E. Kellogg, N. McKinney, D. Spasic, L. Goda, C. Levenson, and J. J. Sninsky.** 1990. Effects of primer-template mismatches on the polymerase chain reaction: human immunodeficiency virus type 1 model studies. Nucleic Acids Res. 18:999–1005.
8. **Lipskaya, G. Y., E. A. Cherkasova, G. I. Belova, S. V. Maslova, T. N. Kutateladze, S. G. Drozdov, M. Mulders, M. A. Pallansch, O. M. Kew, and V. I. Agol.** 1995. Geographical genotypes (geotypes) of poliovirus case isolates from the former Soviet Union: relatedness to other known poliovirus genotypes. J. Gen. Virol. 76:1687–1699.
9. **Minor, P. D., M. Ferguson, D. M. A. Evans, J. W. Almond, and J. P. Icenogle.** 1986. Antigenic structure of poliovirus serotypes 1, 2, and 3. J. Gen. Virol. 67:1283–1291.
10. **Mulders, M. N., G. Y. Lipskaya, H. G. A. M. van der Avoort, M. P. G. Koopmans, O. M. Kew, and A. M. van Loon.** 1995. Molecular epidemiology of wild poliovirus type 1 in Europe, the Middle-East and the Indian subcontinent. J. Infect. Dis. 171:1399–1405.
11. **Nei, M.** 1987. Molecular evolutionary genetics, p. 293–298. Columbia University Press, New York.
12. **Nibbeling, R., J. H. J. Reimerink, M. Agboatwala, T. Naquib, A. Ras, P. Poelstra, H. G. A. M. van der Avoort, and A. M. van Loon.** 1994. A poliovirus type-specific IgM antibody-capture enzyme-linked immunosorbent assay for the rapid diagnosis of poliomyelitis. Clin. Diagn. Virol. 2:113–126.
13. **Nottay, B. K., O. M. Kew, M. H. Hatch, J. T. Heyward, and J. F. Obijeski.** 1981. Molecular variation of type 1 vaccine-related and wild polioviruses during replication in humans. Virology 108:405–423.
14. **Oostvogel, P. M., J. K. van Wijngaarden, H. G. A. M. van der Avoort, M. N. Mulders, M. A. E. Conyn-van Spaendonck, H. C. Rümke, G. van Steenis, and A. M. van Loon.** 1994. Poliomyelitis outbreak in an unvaccinated community in The Netherlands. Lancet 344:665–670.
15. **Rico-Hesse, R., M. A. Pallansch, B. K. Nottay, and O. M. Kew.** 1987. Geographic distribution of wild poliovirus type 1 genotypes. Virology 160:311–322.
16. **Sambrook, J., E. F. Fritsch, and T. Maniatis.** 1989. Molecular cloning: a laboratory manual, 2nd ed., p. E34–E38. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y.
17. **Schaap, G. J. P., H. Bijkerk, R. A. Coutinho, J. G. Kapsenberg, and A. L. van Wezel.** 1984. The spread of poliovirus in the well-vaccinated Netherlands in connection with the 1978 epidemic. Prog. Med. Virol. 28:124–140.
18. **Stanway, G., A. J. Cann, R. Hauptmann, P. Hughes, L. D. Clarke, R. C. Mountford, P. D. Minor, G. C. Schild, and J. W. Almond.** 1983. The nucleotide sequence of poliovirus type 3 leon 12 alb: comparison with poliovirus type 1. Nucleic Acids Res. 11:5629–5643.
19. **van der Avoort, H., G. A. M., J. H. J. Reimerink, A. Ras, M. N. Mulders, and A. M. van Loon.** 1995. Isolation of epidemic poliovirus from sewage during the 1992/93 type 3 outbreak in The Netherlands. Epidemiol. Infect. 114:481–491.
20. **van Wezel, A. L., and A. G. Hazendonk.** 1979. Intratypic differentiation of poliomyelitis virus strains by specific antisera. Intervirology 2:2–8.
21. **World Health Assembly.** 1988. Global eradication of poliomyelitis by the year 2000. Resolution WHA41.28. World Health Organization, Geneva.
22. **World Health Organization.** 1994. Expanded programme on immunization information system. WHO/EPI/CEIS/94.2 EU. World Health Organization, Geneva.
23. **Yang, C.-F., L. De, B. P. Holloway, M. A. Pallansch, and O. M. Kew.** 1991. Detection and identification of vaccine-related polioviruses by the polymerase chain reaction. Virus Res. 20:159–179.

THE PLAGUE

HOW SERI

Graphics by JAI

WHY THE EPIDEMIC BROKE OUT

1

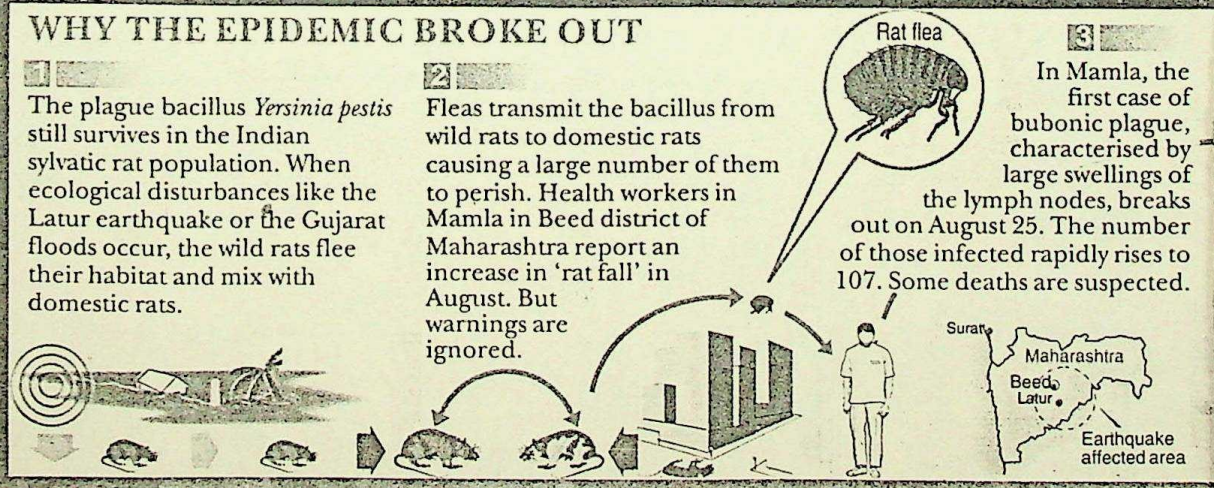
The plague bacillus *Yersinia pestis* still survives in the Indian sylvatic rat population. When ecological disturbances like the Latur earthquake or the Gujarat floods occur, the wild rats flee their habitat and mix with domestic rats.

2

Fleas transmit the bacillus from wild rats to domestic rats causing a large number of them to perish. Health workers in Mamla in Beed district of Maharashtra report an increase in 'rat fall' in August. But warnings are ignored.

3

In Mamla, the first case of bubonic plague, characterised by large swellings of the lymph nodes, breaks out on August 25. The number of those infected rapidly rises to 107. Some deaths are suspected.



OUS IS IT?

A sudden epidemic catches a nation off guard. But as the states respond to the crisis, the death toll remains low, although the danger of the infection spreading still lurks.

By KAI FRIESE with UDAY MAHURKAR in Surat and LEKHA RATTANANI in Beed

A week ago, Surat, an industrial hub of Gujarat, and Beed, a quiet farming district in Maharashtra, were distant from the minds and homes of most Indians. Today, the 51 lakh residents of these two places are all too close. For among their number were the first victims in India in 28 years to be afflicted with that dreaded medieval scourge—the plague. And within days of the outbreak, they began an exodus of biblical proportions that quickly spread the disease to nearby states and even distant cities.

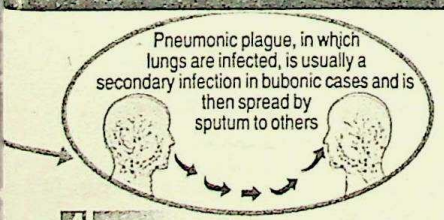
In Surat, the worst hit, with 46 deaths in the first three days of the crisis and another 614 infected, the panic was most evident. Within four days, an estimated four lakh people or 12 per cent of the town's population fled the city. Their faces masked and clouded with fear, they piled onto trains, private buses, motorcycles, autorickshaws and mopeds—anything that would move. "How can we afford to stay when death is staring us in the face?" asked a terrified Madanlal Aggarwal, a shop owner from the Ved Road area as he, along with his wife and son, squeezed together on their two-wheeler to head for their native town of Sirohi in Rajasthan.

Meanwhile, in Beed, where plague cases were first detected, banks of cream-coloured DDT and BHC (benzene hexachloride) pesticide sprays covered several villages like snow. And at the district's only civil hospital, curious onlookers trooped up for a distant peek at patients in the newly-opened isolation ward. Patients like two-year-old Ashwini Panditrao Kadam. The district's youngest plague case, she sobs softly as fever racks her tiny body. The number infected in Beed: 183.

And as people fled these two places in droves, they spread the infection wherever they went. Maharashtra had a total of 432 suspected cases, with Bombay accounting for 51. Fresh cases kept coming in from Jalgaon, Nasik, Dhule and

Patients battling for their lives in a Surat hospital

ASHESH SHAH

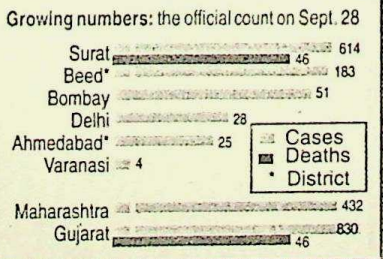


4

An outbreak of the highly contagious pneumonic plague then occurs in Surat on September 21. Bubonic victims migrating from Beed may be the culprits. More than 450 are infected and 41 die. Surat residents flee the city in droves.

5

Reports of victims in Bombay, Delhi and Jaipur start coming in. Key drugs are sold out. Across the country over 1,500 people are suspected to be infected.



Latur, steadily pushing up the numbers. In Gujarat, the figure had touched 832 cases and affected areas included places such as Jamnagar, Rajkot, Baroda, Ahmedabad and Gandhinagar.

Worse, cities in other states in the country were soon reporting cases, although most of them were of people who had fled from Surat: Indore and Bhopal in Madhya Pradesh, Varanasi in Uttar Pradesh, Jaipur in Rajasthan, New Delhi and even Calcutta. Even more troubling was the detection of plague-infested rats in Chittoor district in Andhra Pradesh by government surveillance teams, which showed that the southern states were as vulnerable. And within a day, one death from the plague was reported in Bangalore. In all, the count of those infected was estimated at 1,500 within a week—and rising. The only silver lining was that the ancient scourge had returned in an age of modern prophylaxis, and antibiotics kept the death toll at just 47, a tiny fraction of the patients.

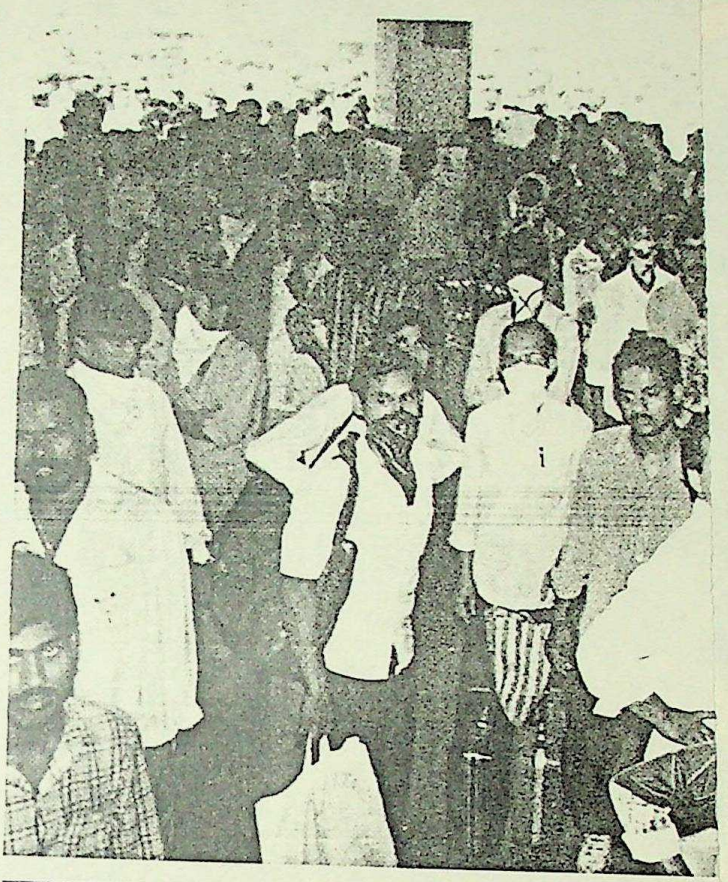
But outside this stricken nation many governments reacted with knee-jerk measures to protect themselves. Almost all the Gulf countries with large Indian labour populations—including Saudi Arabia, Kuwait and Oman—clamped a ban on all flights to and from their countries. Meanwhile other countries introduced medical screening at the airport of all passengers arriving from India. At Frankfurt airport in Germany, jets coming in from India were told to taxi to a distant corner of the airstrip, once reserved for hijacked planes. Passengers were then screened for plague symptoms while still on board. Other nations such as the US, while assuring New Delhi that they would not take any draconian measures against Indian travellers, set up quarantine stations at major airports. The word is out and in all likelihood tourists will avoid India this winter—like the plague.

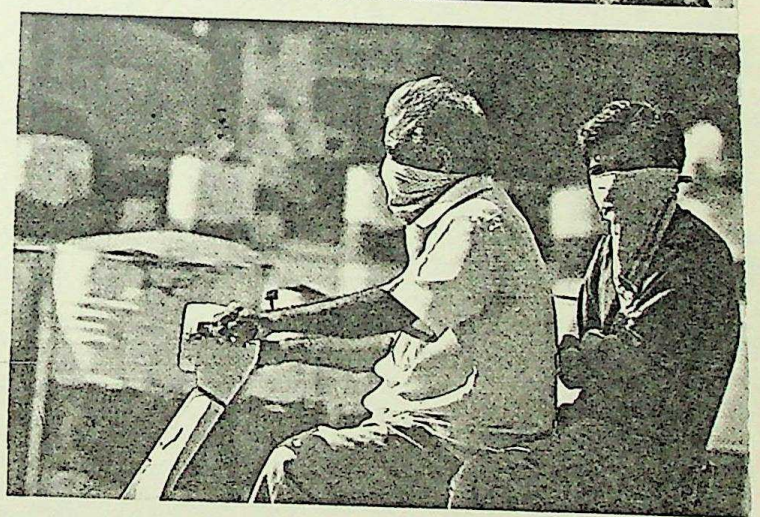
Indeed, as the world watched a nation in chaos, its civic services fumbling to come to grips with the latest catastrophe, India's newly-projected image as an emerging economic powerhouse was in danger of being tarnished. As suspected plague cases accumulated in Bombay's hospitals, fears rose that international shipping might steer clear of this port.

ARE YOU AT RISK?

With fresh cases turning up in various parts of the country daily, the fear among its populace was palpable. Chemists reported panic buying of tetracycline, a scheduled drug considered effective in combating the plague. And general practitioners said there was a marked rise in people with even the mildest fever having themselves checked to make sure they were not infected by the disease. The quest that lurked in most minds: Could I be next victim?

Senior health officials such Dr K.K. Datta, director, National In tute of Communicable Diseases (NIC were understandably cautious. "I do think it is an alarming situation."

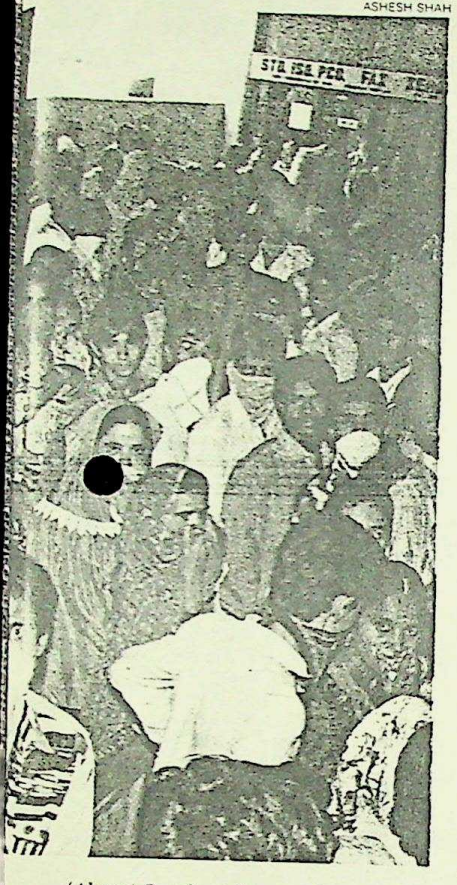




SHAILESH R

Epidemiologists are alarmed because the outbreak has taken

ASHESH SHAH



(Above) People at Surat railway station flock to leave; others flee on two-wheelers

said. But halfway across the globe, at the Centre for Disease Control and Prevention in the US, Dr D.J. Gubler, who has studied outbreaks of the plague all over the world, was plainly concerned. "The form the Indian epidemic has taken is unusual, and the fact that it can be spread by human beings makes it more dangerous," he told INDIA TODAY.

What Gubler is referring to is the phenomenally large number of victims carrying the highly contagious pneumonic plague that has been reported in Surat. Historically, most outbreaks of the plague have been of the bubonic variety, which is characterised by painful swelling of lymph nodes, especially under the armpit and in the groin. All the victims of the original outbreak in Beed were diagnosed to be suffering from bubonic plague. The disease is caused by the bacillus *Yersinia pestis* which still survives in the Indian sylvatic (wild) rat population. The real problem arises when these wild rats come in contact with their domestic counterparts in towns and cities. This often happens when the habitat of the wild rats suffers from a severe ecological disturbance—in Beed, last year's major earthquake in neighbouring Latur is said to be the cause. The domestic rats then fall prey to the plague bacillus themselves, and start dying in large numbers. But to transmit the disease to humans, the oriental rat fleas *Xenopsylla cheopis*, which suck the blood of rats, act as a vector, or a carrier of the bacillus when they bite people.

IF no one has died in Beed so far it is because mortality rates for bubonic plague are much lower than for its more virulent secondary form, pneumonic plague. Untreated bubonic victims can develop pneumonic infections as a complication and the bacillus then causes pneumonia in the chest and pulmonary oedema in the lungs. Death follows within three days. Worse, it is highly infectious and is spread by particles of a victim's sputum. It is this variety that afflicted victims in Surat, 500 km from Beed, two weeks after the first cases were reported in Beed.

While rat deaths, or 'falls' as they are known, were reported in Beed before the outbreak occurred there, in Surat apparently, no such large scale deaths of rodents were reported. The Gujarat authorities themselves are convinced that the epidemic travelled to the state from Beed, just as it later travelled to Saurashtra, Ahmedabad and northern Gujarat with fleeing Suratis. "We strongly feel it has travelled from Maharashtra, which has close interaction with Surat," said Gujarat's Minister of State for Health S. Shelat. "What is more, not a single dead rodent has been found in Surat so far." Meanwhile, the NICD team which performed tests on live rats captured in the city was tight-lipped about its findings and the Beed-Surat transmission theory is far from well established.

Others openly differed with the Gujarat health authorities. At the Haffkine Institute in Bombay, Director V.L. Yemul was sceptical about the theory that the plague had been transmitted from Beed to Surat. He maintains that the bacteria in Beed are much less virulent than those found in the pneumonic patients in Surat and it is unlikely that one strain could have changed its form so drastically in the short span of

unusual and contagious pneumonic form.

THE BAD NEWS:

- Pneumonic plague is spread mainly by airborne droplets of sputum from infected persons and is highly contagious. Over 1,500 cases were reported nationwide till September 29. It has already spread to 7 states.
- Ignorance of the disease and its cure hampers a speedy check of the epidemic. Worse, the progress of pneumonic plague which has an incubation period of 3-4 days, is quick and in untreated victims, invariably fatal, unless antibiotic treatment is taken early.
- Poor monitoring of cases and strained health services means that it will take longer to bring the epidemic under control.
- There is only one surveillance unit in the entire country (in Karnataka) to monitor evidence of plague among rodents, leaving little chance of early warning in case of a fresh outbreak of bubonic plague.
- Lack of urban sanitation hampers efforts to keep the rodent and flea population under control.
- The epidemic could spread to states such as Bihar or Orissa where health services are poor and which may be unable to contain it.

THE GOOD NEWS:

- The death toll (officially 47 on September 29) is low compared to the number of people infected.
- Of the suspected 1,500 cases nationwide, as of September 29, most are Surat residents and those who fled the city.
- In vulnerable cities like Bombay, the number of those infected is relatively low even a week after the first cases were reported.
- Most patients who received early antibiotic treatment have recovered rapidly. In treated cases today, the expected mortality rate is a low 5-10 per cent.
- After initial shortages, there are now enough drugs available to combat the epidemic. WHO officials say the epidemic can be controlled within three weeks.
- Most deaths occurred in the first few days when health officials were unprepared. The toll has not risen dramatically since.

ASHESH SHAH

time between the two outbreaks.

But whatever the genesis of Surat's pneumonic outbreak, the fact that victims of this form of the disease have dispersed across India heads the list of immediate perils. Unless these victims are confined to isolation hospitals till they are cured, the disease will certainly spread. But given India's poor health infrastructure, reporting and monitoring of cases is highly erratic. The same concern was weighing heavily on Dr T. Verghese, former director of NICD and currently the deputy director-general, health services, as news came in that two patients in a Delhi hospital had tested positive for pneumonic plague. "More case are bound to be confirmed," said Verghese. And two days later another 19 were. All were from Surat or had some communicable contact with residents from that city. But a newspaper of September 29 then caused further alarm by reporting that one patient in a Delhi hospital was suffering from the bubonic plague.

Health officials refuted the report. But the incident focussed on a related risk, still clouded in a miasma of uncer-

HEMANT PITHWA

tainty: the possibility that infected rats—no strangers to trains or other means of human locomotion—may carry the disease to the far corners of the nation. So far, this potential threat has remained at the bottom of the agenda of apprehension simply because rats have not yet been clearly implicated in the Surat outbreak. But the danger lurks in the air, like the droplets of sputum which have already spread the more virulent version to distant cities.

(Above) RAF men guard an isolation ward; a scientist tests a rat

Such fears will continue to gnaw at the public imagination, and hopefully the administrative conscience, until the more obvious danger has passed. And with rat surveillance operations virtually non-existent in most parts of the country, the risk of a new focus of bubonic plague emerging has hardly been laid to rest. In fact, the country's only active plague surveillance unit before the current outbreak was headquartered in Bangalore, with a sub-unit in Kolar. The unit moves around frequently in the surrounding southern states, testing wild rats to check whether they harbour the plague bacillus. It also looks out for reports of rat falls in urban areas and checks the reasons for the falls. According to unit chief Dr Shyamal Biswas, an increasing number of wild rodents have been testing positive for the plague since 1989.

An NICD warning that rodent plague was endemic in the Latur area

which again is far from reassuring. Other cities such as Delhi have no surveillance units. The lack of a proper monitoring system means that most cities could be caught unawares by a plague epidemic, exactly as Surat was.

Nonetheless, by the end of the month, there were some genuinely, if faintly, encouraging portents. Ironically, even as Verghese received the bad news about the cases in Delhi, there was good news from Surat. "There have been no deaths in the last 24 hours," said a satisfied A.K. Mukherjee, director-general, health services.

But while a nation, now in fear of the slightest cough, probes its armpits for lymph nodes and stocks up on tetracycline, hope and despair are polarised on the same lines. The good news is that the remedies are well-known and, despite the panic buying, in supply. They are also effective. Whereas in the past the mortality rate of bubonic plague varied from 50 to 90 per cent and the pneumonic form was almost invariably fatal, among treated cases today, mortality is only 5 to 10 per cent, and even the gravest infections respond to antibiotics—streptomycin, tetracycline, kanamycin, chloramphicol—if treated early enough. The bad news, of course, is no one knows how many cases have spread or to where. As it is, 57 infected patients who escaped from a Surat hospital, are still untraced by the special task force set up to track them down. And so an uncomfortable balance remains: a nation at risk of infection, but certain of treatment. But there should have been more certainties than that.

COULD IT HAVE BEEN PREVENTED?

In retrospect, it seems clear that the outbreak of the plague might never have reached its current proportions if some swift action had been taken more than a month ago in the village of Mamla in Beed. It was here that the first obvious sign of the plague—a rat fall—was noticed as early as August 5. The rat falls were accompanied by dramatic swarms of fleas, says Mukesh Waichankar, a health inspector from the Kuppa primary health centre (PHC), a few km away, who came to the village a day after the rat falls were reported to the District Health Office (DHO) in Beed town. "I came and started looking for the fleas and when I looked down, my white pants were covered with fleas."

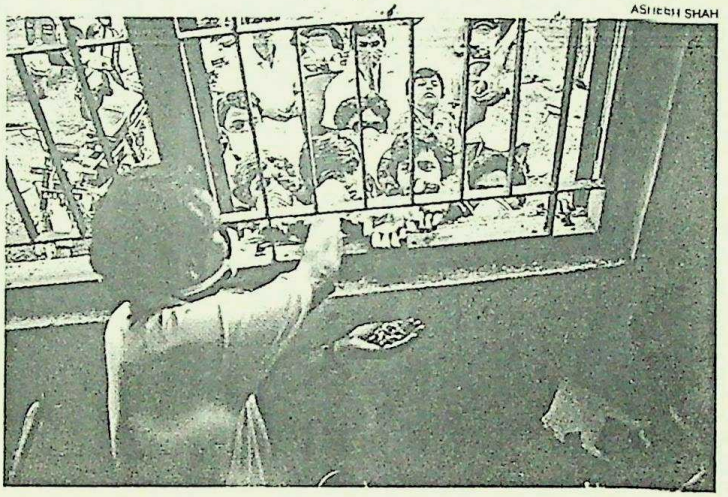
fell on deaf ears.

Fight Against Time

THE irony of the situation is unmistakable. The Rs 325-crore Indian Drugs and Pharmaceuticals Limited (IDPL), a public sector company manufacturing tetracycline—the drug used to treat pneumonia, some respiratory disorders, and the plague—had accumulated losses of Rs 625 crore. Demand was slack and it was seriously contemplating stopping production of the antibiotic. But news about the outbreak of the plague in Surat changed everything. Overnight, there was a surge in demand and IDPL is now running three shifts in its two plants. IDPL produces 90 per cent of the tetracycline bulk drug, the raw material used to make formulations like capsules and tablets.

As panic about a plague epidemic gripped the country, tetracycline simply disappeared from the market with people hoarding whatever stocks they could lay hands on. The sudden, excessive rush for the drug caught the industry unprepared and manufacturers were unable to cope with the enhanced demand. The result: the country was hit by an acute drug crisis.

ASHISH SHAH



A mad rush at a chemist's shop for tetracycline tablets

But the point everybody was missing was that tetracycline is not a preventive but a prescription drug. As N.K. Shah, the WHO's representative, explains: "Tetracycline should be used only if a person is in touch with an affected person. It, in fact, has certain side-effects."

All the same, major industries in the Gujarat belt near Surat immediately sent tetracycline supplies to their workers. Says Essar's spokesman, Sunder Rajan: "The minute we heard about the crisis in Surat, we airlifted over 30,000 capsules of tetracycline for the 800 workers at the Hazira plant." It was the same with companies such as ONGC and Reliance.

Meanwhile, drug companies have increased their production capacities. Pfizer Ltd has expanded its production by 20 per cent. Ambalal Sarabhai, which manufactures both tetracycline and streptomycin, has doubled its capacity to 1 tonne per day, or 10 lakh capsules. It also manufactures tetracycline from the basic stage. Another firm, Cyanamid, has increased its production of Ledermycin (a brand name for tetracycline). The Government is also planning to import the drug to stem the panic-buying. IDPL and other firms are expected to supply 30 million capsules—12.5 million have already been supplied—by October 7. The time frame is just enough to process the bulk drug. Tetracycline is made from a highly technical fermentation process and it takes between two days and two weeks to manufacture the capsule. Meanwhile, the lone preventive, the plague vaccine, is already being imported from Russia and a limited quantity is being produced by Bombay's Haffkine Institute. However, if the plague spreads rapidly, it will throw everything out of gear. It is now a fight against time to beat the scourge.

—SHEFALI REKHI with ROBIN ABREU

The Scourges Return

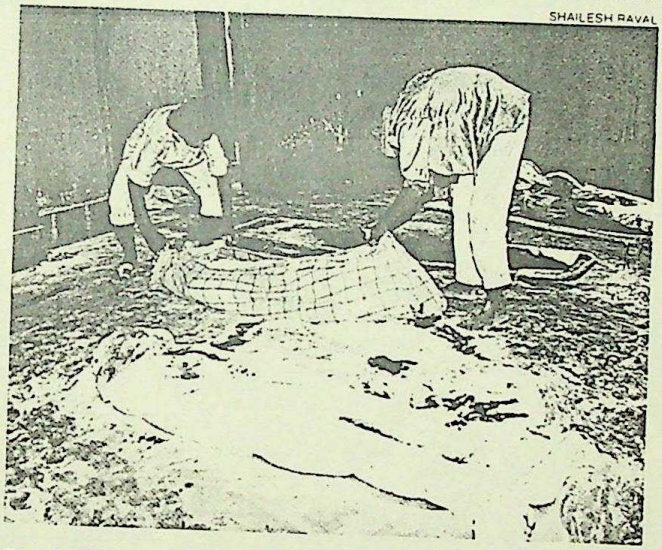
THEY were believed to have been wiped off the face of the earth, relegated to the pages of medical history books. But the reality is frighteningly different. Not only is there a resurgence of long-forgotten diseases such as the plague and kala azar but new kinds of colourful bacteria are emerging under the microscope, even faster than you can see them.

While the dreaded *Yersinia pestis* bacterium has made a comeback in India after a gap of 28 years, other diseases such as malaria, pneumonia, and tuberculosis are also showing a steady increase. The figures are revealing:

* Kala azar cases have gone up from 18,689 in 1977 to 50,745 in 1991.
* Malaria affected only 50,000 people in 1961, but last year as many as 80 lakh people were affected.
* Every year, 11 lakh people are afflicted by tuberculosis.

The basic problem lies with the bacteria. They have an unusual habit of swapping chromosomes among each other, thus developing a variety of strains and driving microbiologists up the wall. Many bacteria have also become drug resistant with the result that patients refuse to respond to known cures. This, in fact, is the real danger today. The bacteria divide and multiply and develop a resistance to the antibiotics being taken. In crowded cities, these resistant strains then spread like wildfire.

This is a terrifying new medical phenomenon. Many infectious micro-organisms, long known to be losing the battle against antibiotics, have shown this resistance. For instance, the cheap and effective Chlorophenisol had made typhoid totally curable. But the wide use of this drug enabled the bacteria to evolve into a new, completely resistant, species. Today, Ciproflox, three times more expensive, is being used and laboratories warn that the bacteria might develop resistance to this drug too.



SHAILESH RAVAL

Disinfecting corpses: another preventive measure

The bacteria have also developed immunity to preventive measures that were successful earlier. For example, in the '60s, the widespread spraying of DDT destroyed large numbers of the *Anopheles* mosquito which causes malaria, but it is no longer proving effective.

The abysmal state of civic facilities is another reason for the increase in such diseases. The huge festering colonies of slums in the metros have no proper drinking water, sewage pipes or medical facilities. Infectious diseases have found a ready breeding ground in these blighted ghettos.

The situation today is that India faces a double whammy: of medieval scourges like the plague, and modern-day diseases like cancer, AIDS and diabetes. In fact, doctors expect a combination of the two to have a devastating effect on the national health. As Dr Randeep Guleria, a tuberculosis specialist at AIIMS, says: "Once the AIDS epidemic starts in India, new resistant forms of tuberculosis will make sure that our entire programme collapses."

Add to this the multiple new strains of microbes causing malaria, kala azar, pneumonia and cholera, and the health department has its work cut out. The last thing it needed at this juncture was a visit from the slim, rod-shaped plague bacteria.

—VIJAY JUNG THAPA with NANDITA SARDANA KOCHHAR

The absence of

But in Beed town, a sleepy mofussil settlement of 2.8 lakh inhabitants, these dramatic indications of bubonic plague were regarded by the DHO as merely a 'rat and flea nuisance' and referred back to a sub-centre of the Kuppa PHC. The sub-centre, for its part, had few means at its disposal to do anything about the 'nuisance' and fulfilled its obligations by 'monitoring' conditions in Mamla. In other words nothing much was done. In fact, it was only when Abhimanyu Arjun Savle, 18, approached the Kuppa PHC on August 26 complaining of fever, enlarged lymph nodes and pain, that the alarm bells were sounded and the health authorities realised they were looking at a fresh chapter in medicine. It was then that the district authorities began a house-to-house search for other plague victims in Mamla, and soon identified 35 suspected patients among the villagers. Pesticide spraying was also initiated in the village—thankfully, well before the state authorities finally lumbered into action with a communique on the threat of the plague on September 5.

Seven years ago, the authorities might have reacted faster. At that time, Maharashtra had a full-fledged plague surveillance unit of its own. But even as the first cases of bubonic plague were diagnosed in Beed, the state Government made no move to revive the unit. That would have to wait until the national panic had begun on September 22.

The state Government has also been accused of inviting disaster by ignoring the possibility that the plague would break out in the wake of the Latur earthquake. The most glaring evidence that the state's health administration was asleep on this issue is the fact that only last year an NICD report on the earthquake, stated that "since the Latur-Sholapur axis is known to be endemic for rodent plague, surveillance of rodent-borne human infections is warranted in the area". But the Maharashtra Government was not stirred into action. "There were no guidelines set down by the NICD as far as preventive

active surveillance system made swift containment unlikely.

measures were concerned," says Maharashtra Health Minister Pushpatai Hirey in her defence. "Nor was there any mention of the plague, or of Beed." It would seem that the state's Health Ministry expected to be spoon-fed such specifics.

If such failures negated the possibility of preventing the outbreak, subsequent apathy also obviated the possibility of effective containment. It seems incredible now, but when the first victim of pneumonic plague, a 19-year-old diamond cutter named Natubhai Prajapati, approached a doctor in Surat on September 19 with high fever and blood-specked sputum, the physician hadn't a clue about what was really wrong with him. Although bubonic plague was by now well advanced in Beed, it wasn't until seven patients had died in Surat's Ashaktashram Public Hospital by September 21 that doctors there finally guessed that they had been dealing with the plague. Only then did they alert their colleagues at the city's civil hospital where another 12 patients were in their death throes.

From those early undiagnosed deaths, the tale of human error continued to the 'loss' of 57 plague patients who inexplicably fled their hospital beds in Surat on September 25. Jawans of the Rapid Action Force (RAF) were stationed at the Civil Hospital the same day to avert further escapes and to prevent relatives of the patients from crowding the hospital and assaulting the doctors. But worse was to follow. Even as the deaths in Surat mounted, Gujarat Chief Minister Chhabildas Mehta proclaimed that pneumonia was the culprit because "there was no rat problem in the city". The chief minister was apparently ignorant of the fact that pneumonic plague is spread not by rats or fleas, but by particles of human sputum.

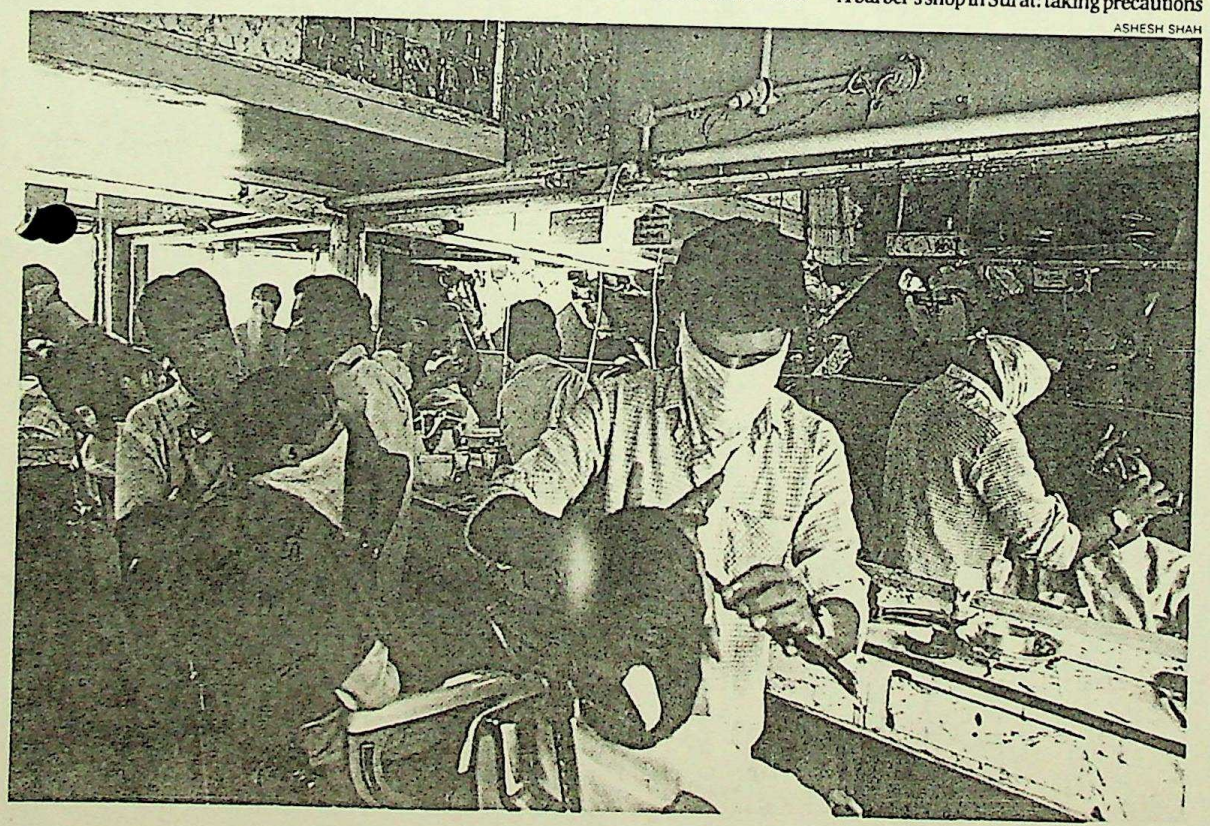
IN one short week, the plague had also produced many more villains than it has victims. People like the 1,000 doctors—a quarter of the fraternity in Surat—who fled their city as news of the pestilence broke out. Or the journalists of several local dailies who spread that kind of panic by publishing concocted death tolls in the hundreds at a time when less than 30 people had died.

But once such derelictions had reached critical mass, there was no one to point a finger at any more. It became a vicious cycle. With nearly half the 2,500 class IV civic workers having fled Surat in panic, even basic services such as sanitation—always very basic in Surat—ground to a halt, while the emergency service of distributing tetracycline was crippled at birth. "They have left us to the Almighty," shouted an angry Nagjibhai Patel, 38, a diamond unit worker. And as the anger mounted, irate citizens began to harass the remaining public servants and virtually loot tablets and pesticides from zonal offices. "We were helpless," complained Surat's Deputy Municipal Commissioner R.D. Desai who was in charge of the Ved Road and Katargam areas, the epicentre of the outbreak. "How could we leave our staff at the mercy of the mobs? And how could these people expect the staff to deliver the goods when they themselves were coming in the way?"

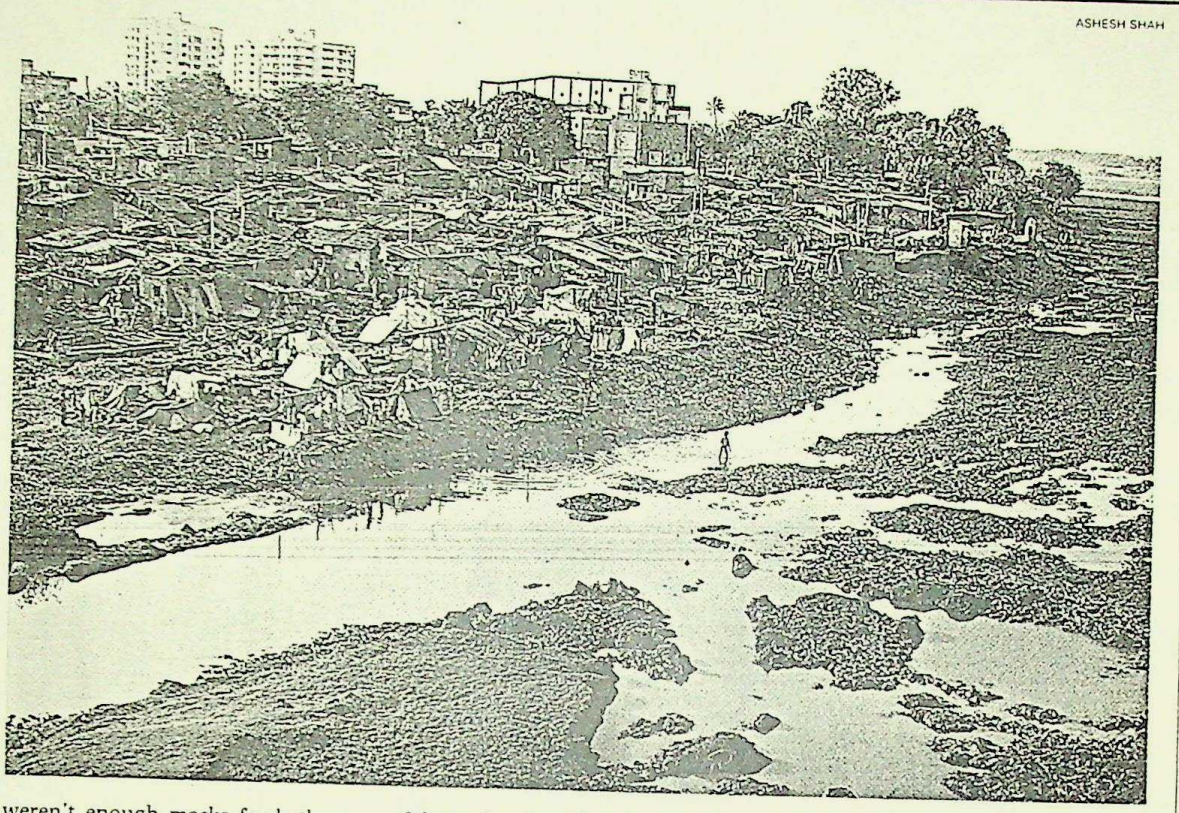
Back at the civil hospital, where all the patients were being treated, the situation was equally chaotic. There

A barber's shop in Surat: taking precautions

ASHESH SHAH



ASHESH SHAH



One of the swamps of filth in Surat

weren't enough masks for both patients and doctors. Complained microbiologist Hemant Pandya, who worked on the culture tests that ultimately proved that the disease was indeed pneumonic plague: "When we are exposing ourselves to risk while carrying out the tests, the minimum that the administration can do is guarantee our safety."

But it was not just at the heart of the epidemic that such problems prevailed. On September 24, when the Surat-Bombay shuttle, Flying Ranee, pulled into Bombay Central and disgorged 5,000 passengers—twice its capacity—the fleeing citizens of Surat were met by a spectacle that must have seemed excruciatingly familiar: a tetracycline dispensing *shamiana* with no tetracycline at hand. Nor was there any thought of screening the new arrivals for signs of infection.

WHAT MORE NEEDS TO BE DONE?

Surveillance, screening, the distribution of medication. Such obvious measures which are detailed in the most basic pamphlets on plague control seem to have taxed the capabilities of the authorities all over the country in the first days of the epidemic. "There is panic at all levels, not just among the public", said Verghese, "and the authorities need to get a grip on themselves." By the end of the week, however, there were some signs that the initial paralysis was wearing off. Suddenly, the most gargantuan tasks were being attempted. In Bombay, Additional Municipal Commissioner Sudha Bhave said that a house-to-house search would be undertaken to detect cases of the plague. "We'll begin with the slums," said Bhave, and by the third day of the search, the BMC managed to cover 20 lakh homes. They still have a long way to go: more than half of Bombay's 10 million inhabitants are slum-dwellers.

Still, it's too late now to be daunted by figures. In Beed, where the plague control drive has been in action for a month, budgets and pharmaceutical supply statistics have already ascended unheard-of heights. For instance, 10 lakh tablets of tetracycline and three lakh Septran tablets had been distributed by September 25, as against the district's normal annual consumption of 12 lakh tablets of these antibiotics. Another 10 lakh pills have already been ordered. Similarly, 30 metric tonnes each of DDT and BHC—again a figure close to the normal annual requirement—have already been sprayed during anti-flea operations. And while the district's rat control measures had a measly budget of Rs 20,000 during 'peacetime', today, 10 lakh quintals of zinc phosphate rat poison have already been purchased at the cost of several lakh rupees.

Elsewhere, Karnataka, already blessed with the country's only plague surveillance unit (prior to this black September), was setting an example of the kind of precautions that would be desirable all over India. "The Government feels that any outbreak of the plague in Karnataka is unlikely, but the public has been instructed to immediately notify health officials if they notice any 'rat fall'," said Minister for Health and Family Welfare Dr M. Reddy. Karnataka health officials and workers are gearing up to stem any spread of the plague in the northern part of the state from the neighbouring Maharashtra districts.

India's health expenditure is a paltry 1.5 per cent of its GDP.

Controlling the epidemic is the government's sternest test.

The border districts have been put on red alert. Detailed instructions have been issued to district health officers to orient the staff, including those at the PHCs and the sub-centres, to keep a close watch and detect any symptoms of the disease. Government medical stores in Karnataka have stocked 30 lakh tetracycline tablets. Fifty tablets have been issued to each auxiliary nurse midwife sub-centre in the vulnerable districts. Besides, all the sub-centres have been instructed to give tetracycline tablets to patients who complain of plague symptoms without waiting for any laboratory results.

But while such massive mobilisations of the public health machinery will hopefully be routine throughout the Union, many states will surely find their services shuddering under the strain. And as Dr N.K. Shah of the WHO says "the epidemic could be over within three weeks so long as it does not spread to states with a poor health care infrastructure." Yet according to Dr Lalit M. Nath, the dean of the All India Institute of Medical Sciences, New Delhi, "We have systematically demolished the public health care system."

India's total expenditure on health is only 1.5 per cent of its GDP as against WHO's recommendation of a minimum of 5 per cent.

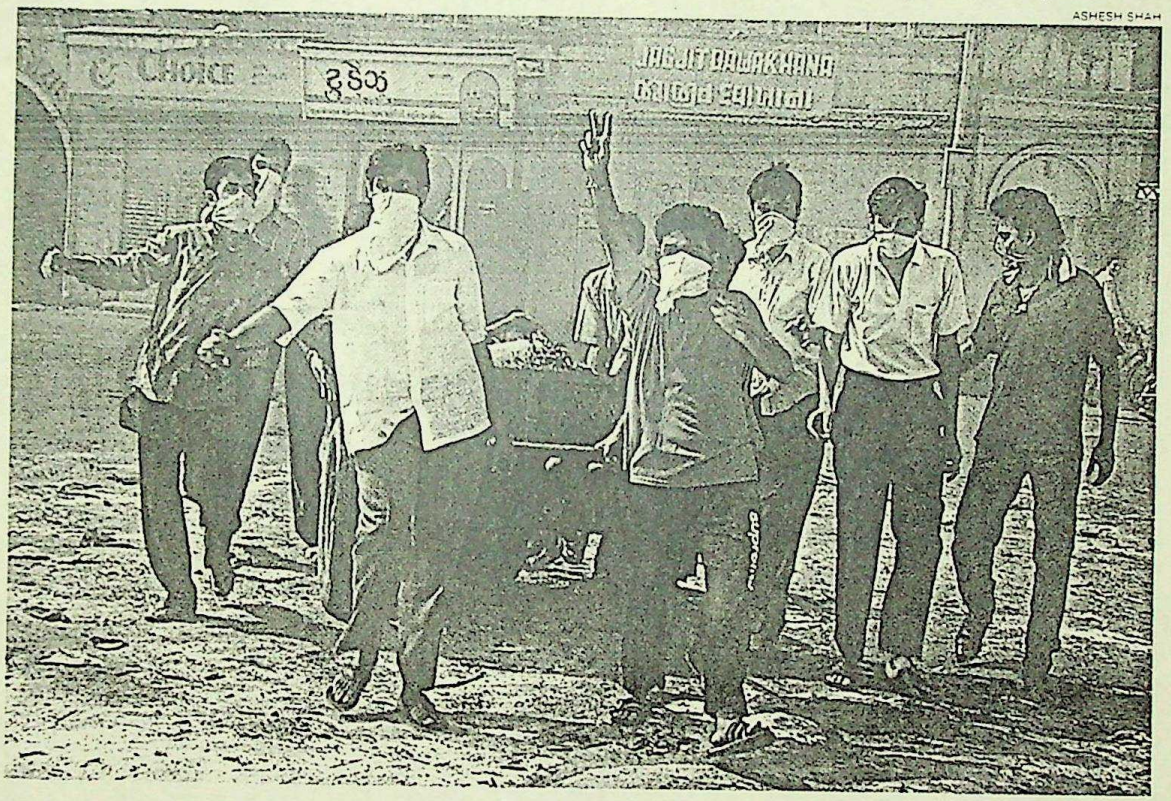
To meet the current challenge, the Indian state will spare no expense as it puts its pharmaceutical factories in high gear, distributes vast quantities of drugs and pesticides and deploys its employees all over the country. But when the emergency is past, lessons will have to be learned and costs counted and balanced against the benefits that institutions like the public health services and the plague surveillance system might have reaped had they been more generously funded. Better funding for urban sanitation would also be welcome, to ensure that, apart from other things, rodent populations decline significantly. As Prime Minister Narasimha Rao, who kept himself constantly updated on the plague situation, said: "It's both a warning and an opportunity for us to keep our cities clean. We just can't be complacent."

Meanwhile, in Surat at least, the lethal aspect of the plague extends itself to the economic life of what was so recently a boom town. According to the South Gujarat Chamber of Commerce, the daily cost to industry is close to Rs 200 crore. Such collateral losses—to the tourist industry, through cancelled business, shut-down factories and more—can only mount throughout the country. A plague epidemic is not swiftly subdued, as Gubler reveals. "Peru had a large bubonic epidemic last year," he says. "They're still fighting it."

For the Indian Government, the task remains to make the best of what so far has been a bad job. As the state lumbers into action, it must make good with the scale of its effort what it lacked in speed. It may not have faced a challenge of this magnitude for decades. But failure to control the current scourge will be catastrophic. Not perhaps in any large loss of human lives—thanks to modern antibiotics—but to India's image and its economy. No government has faced a sterner test.

—with ARUN KATIYAR in Bombay and SARITHA RAI in Bangalore

ASHESH SHAH



Garbage being collected for burning

global polio eradication

Polio news

Issue 29
Spring 2007

WHO DG Margaret Chan calls urgent stakeholder consultation – consensus reached on need for rapid completion of polio eradication

On 28 February 2007, governments, donors, international agencies, private foundations and the spearheading partners leading the drive to eradicate polio mapped out a massive assault on polio. With indigenous wild poliovirus surviving in only parts of four countries – Nigeria, India, Pakistan and Afghanistan – delegates agreed everything needed to be done to reach and finish the job once and for all.

For the first time ever, the Heads of State of the four remaining endemic countries sent their personal envoys to WHO, signalling a new level of engagement that could now move polio eradication beyond the health agenda, and help overcome the remaining operational challenges to reaching every child.

Spearheading partners in polio eradication (from left to right): Rotary International President Bill Boyd, US CDC Director Dr Julie Gerberding, UNICEF Deputy Executive Director Kul Gautam, WHO Director-General Dr Margaret Chan. (See special photo feature on pages 4 & 5)

Each country announced innovative new tailored approaches to ensure the massive assault reaches deep into the last strongholds of the poliovirus. The Special Advisor to President Karzai outlined a new, multi-pronged approach to increase access to children in conflict-affected areas of southern Afghanistan; the Minister of Health of Pakistan explained how traditional jirgas would be systematically used to engage the leadership in tribal areas; the Minister of Finance of India stood up in Parliament in Delhi on the same day as the consultation, committing nearly US$ 290 million in domestic resources. Most striking, the Governor of Kano, Nigeria – the northern state at the centre of a major international controversy that led to suspension of polio immunizations in 2003 – sent his Health Commissioner to outline their plans to lead the eradication effort in that area. The heads of these governments have clearly stated in one resounding voice: we will do what it takes.

Additionally, the consultation was presented with new evidence underlining the humanitarian and economic case for finishing eradication. A new study from Harvard University demonstrated that over a 20 year period, controlling polio at high levels would cost more, in human suffering and dollars, than finishing eradication. If polio eradication were stopped, hundreds of thousands of children would again be paralysed by this disease over the coming years, and billions of dollars would be spent on outbreak response activities, rehabilitation/ treatment costs and associated loss of economic productivity.

Success depends on rapid injection of cash

With a massive assault on polio now mapped out, and political engagement at country level higher than ever, success in polio eradication now requires an urgent injection of funds. Unless additional funds are contributed quickly, the global polio eradication programme will have to start cancelling or scaling back key activities as early as May. This cannot be allowed to happen. The global funding gap of US$ 575 million for 2007-2008 must be urgently filled.

"As an international community, we have very few opportunities to do something that is unquestionably good for every country and every child in the world," said Dr Margaret Chan, WHO Director-General. "We know what needs to be done to succeed. All stakeholders share a collective responsibility to ensuring this perpetual gift can be given to children across the world."

Further information on the funding situation available at www.polioeradication.org/fundingbackground.asp

Contents

NOW, MORE THAN EVER

Page 8: India leads way in providing domestic resources

On 28 February 2007, Indian Finance Minister Shri Palaniappan Chidambaram announces domestic contribution of nearly US$290 million for polio eradication. The international donor community must now rapidly fill the remaining global funding gap of US$575 million for 2007-2008.

STOP POLIO FOREVER!

World Health Organization

ISSN 1727–3730

A Newsletter for the Global Polio Eradication Initiative
World Health Organization
in association with
Rotary International,
United Nations Children's Fund
and the Centers for
Disease Control and Prevention

CDC

unicef

Massive assault on polio in 2007

NEW TAILORED APPROACHES TO REACH ALL CHILDREN IN REMAINING ENDEMIC POCKETS OF NIGERIA, INDIA, PAKISTAN AND AFGHANISTAN

New tailored approaches to reach all children are being implemented in 2007 in the remaining endemic pockets of Nigeria, India, Pakistan and Afghanistan. Key to success will be to rapidly raise the levels of vaccination coverage and immunity in the areas with endemic transmission, to at least those levels attained in the polio-free areas of those countries. Specific milestones have now been agreed, to meet those necessary levels by end-2007, and sustain them for as long as necessary to interrupt the remaining strains of wild poliovirus transmission.

Tailored approaches in 2007 in endemic areas

India: close immunity gap in children aged <2 years

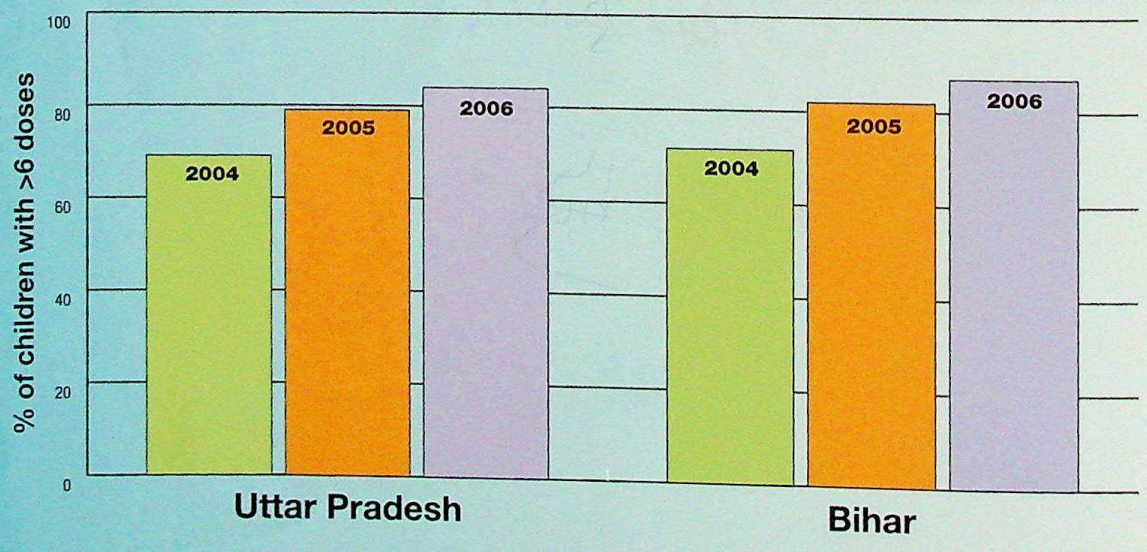
In India, despite an outbreak in 2006 which resulted in a ten-fold increase in new cases compared to previous year, a thorough review of epidemiological and programmatic data has shown that the remaining population immunity gap which continues to sustain transmission is among children aged less than two years (83% of all cases in 2006 aged <3 years and 73% of all cases aged <2 years).

TAILORED APPROACH IN 2007:

- Large-scale supplementary immunization campaigns every four weeks (in response to large birth-cohorts)
- Focus on high-risk districts of Bihar and Uttar Pradesh – the only two states to sustain indigenous transmission of wild poliovirus
- Special attention on infants and very young children, including tracking of newborn children
- Use of monovalent oral polio vaccines (mOPVs), to maximise impact of each immunization contact.

India: Immunization status children aged <2 years

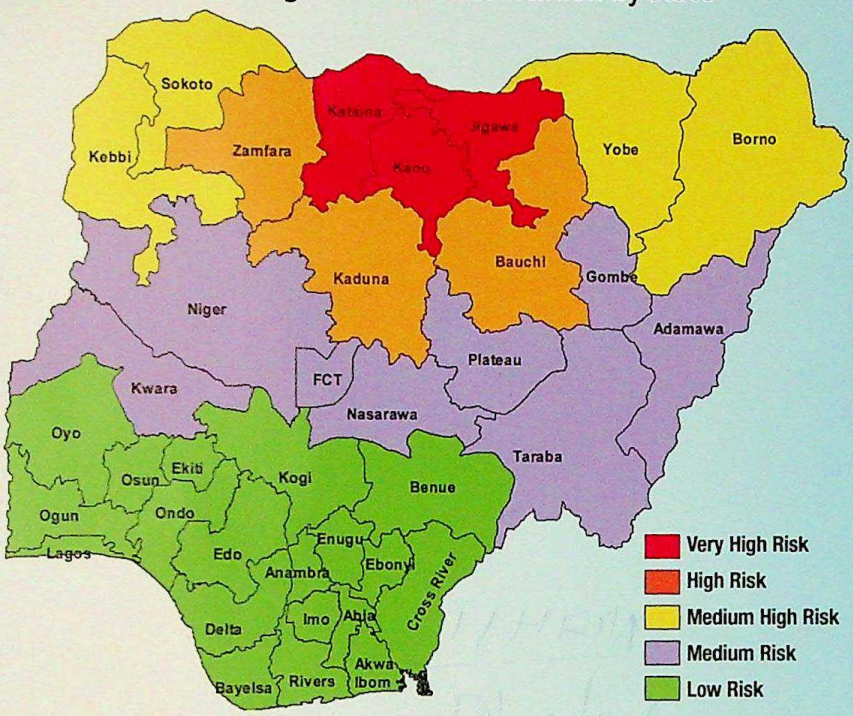
In non-polio acute flaccid paralysis (AFP) cases



Nigeria: focus on 'very high risk' areas

In Nigeria, substantial progress was achieved in the second half of 2006, following the introduction of 'Immunization Plus Days' (IPDs), during which other vaccines and health interventions are offered to communities, in addition to OPV. Since the introduction of IPDs, the proportion of children in northern states who had never been immunized was reduced to an average of 20% by end-2006, from >50% at end-2005. However, three northern states – Kano, Katsina and Jigawa – have been classified as 'very high risk', due to ongoing coverage gaps of >25% during campaigns.

Nigeria – risk classification by state



TAILORED APPROACH IN 2007:

- State-driven IPDs, to allow most effective implementation
- Increased focused on 'very high risk' areas, eg Kano, Katsina and Jigawa
- Increased engagement of religious leaders and Quranic schools to promote IPDs.

Pakistan and Afghanistan: address areas of 'limited access' and cut cross-border transmission

Most areas of Pakistan and Afghanistan are today polio-free, with indigenous transmission of endemic poliovirus being sustained in both countries among populations in insecure areas, mobile populations and those living in socially conservative areas.
The focus is to rapidly close the immunity gap among these hard-to-reach populations.

(From left to right) Minister of Health Afghanistan Dr Sayed Mohammad Amin Fatimi and Minister of Health Pakistan Mr M Nasir Khan jointly addressed a historic health jirga of tribal leaders in December 2006, urging support to ensure no Afghan and Pakistani child slips through the net. Both Ministers of Health personally immunized children on both sides of the border.

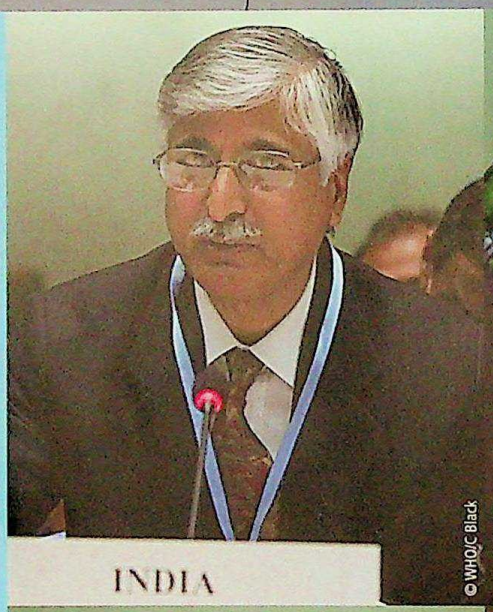
TAILORED APPROACH IN 2007:

- Coordinated SIA and surveillance activities between both countries
- Focus on subnational immunization activities in infected and high-risk areas; systematic redeployment of technical staff from polio-free areas to support activities in the infected and high-risk areas
- Specific polio campaigns to target mobile populations
- Mapped population movements, vaccination posts at key nomadic gathering posts and border crossings
- Systematic use of **jirgas** to increase tribal leader engagement
- Exploring possible Days of Tranquility in Afghanistan
- In areas of insecurity, increased involvement of all parties, including government, anti-government elements, military groups, NGOs and tribal leaders, to allow safe passage of polio vaccinators.

Urgent stakeholder consultation on polio eradication, Geneva, Switzerland, 28 February 2007

© WHO/C Black

The spearheading partners address the urgent stakeholder consultation on 28 February in Geneva.

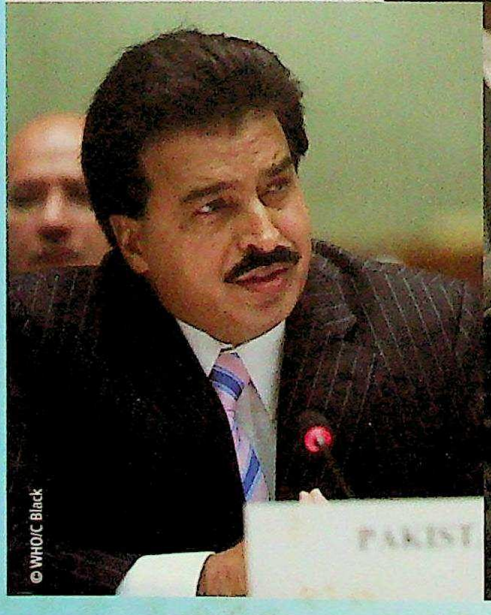


© WHO/C Black

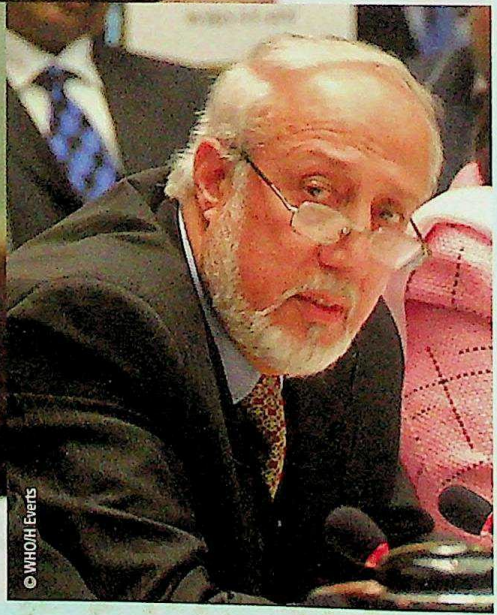
Shri Naresh Dayal, Secretary of Health and Family Welfare, Government of India. The Government of India contributed nearly US$290 million in domestic resources for polio eradication.


© WHO/C Black

Mrs Amina Ibrahim, Senior Special Assistant to President Olusegun Obasanjo on MDGs, Government of Nigeria. For the first time ever, the heads of state of all four endemic countries sent personal envoys to WHO, signalling a new engagement that is moving polio eradication beyond the health agenda. Most striking, the Governor of Kano, Nigeria – the northern state at the centre of a major international controversy that led to suspension of polio immunizations in 2003 – sent his Health Commissioner to outline their plans to lead the eradication effort in that area.


© WHO/C Black

Mr M Nasir Khan, Federal Minister for Health, Pakistan, outlined his country's plans to systematically engage traditional jirgas to foster the leadership in tribal areas.


© WHO/H Everts

Dr N Mojadidi, Advisor to President Hamid Karzai on Health & Education. Afghanistan is implementing a new, multi-pronged approach to increase access to children in conflict-affected areas of southern Afghanistan.

"A collective responsibility for polio eradication."

The international donor community must now urgently take the case for polio eradication to major international development fora, including to the G8 Development Ministers Meeting in March, the OECD Development Assistance Committee High Level Meeting in April, and the GAVI Fund Board Meeting in May. Key to success is to rapidly fill the global funding gap of US$575 million for 2007-2008.

(From left to right) Mr Paul Fife, Director, Norwegian Agency of Development Cooperation; Ambassador Babacar Ba, Permanent Observer of the Organization of the Islamic Conference (OIC) to the United Nations Office in Geneva.

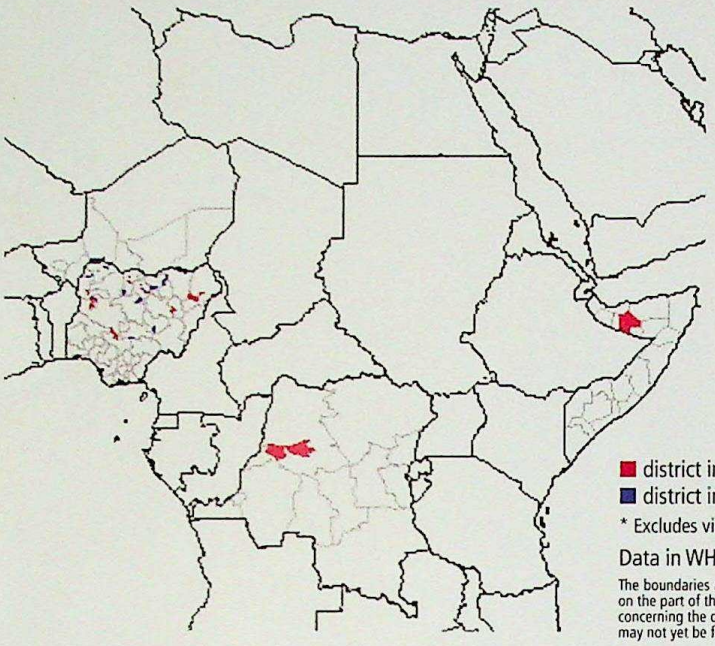
(From left to right) Mr Julian Schweitzer, Director, Human Development, World Bank South Asia Region; and Mr Kent R Hill, Assistant Administrator for Global Health, US Agency for International Development (USAID).

US Undersecretary of State for Democracy and Global Affairs Paula Dobriansky.

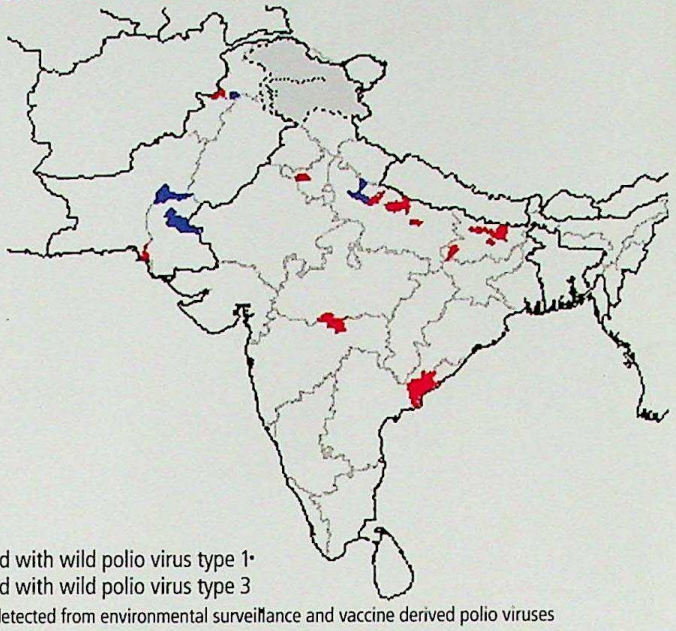
WHO: no longer 'business as usual', as polio eradication becomes a top, cross-regional priority for the Organization. (From left to right) Dr Samlee Plianbangchang, Regional Director, WHO Regional Office for South-East Asia (SEARO), Dr Shigeru Omi, Regional Director, WHO Regional Office for the Western Pacific (WPRO).

Urgent stakeholder consultation: endemic countries, G8 countries, development agencies, private foundations, the Organization of the Islamic Conference (OIC), the African Union (AU) and the spearheading partners mapped out a massive assault against polio.

Wild Poliovirus infected districts*, 2007 - Africa



Wild Poliovirus infected districts*, 2007 - Asia

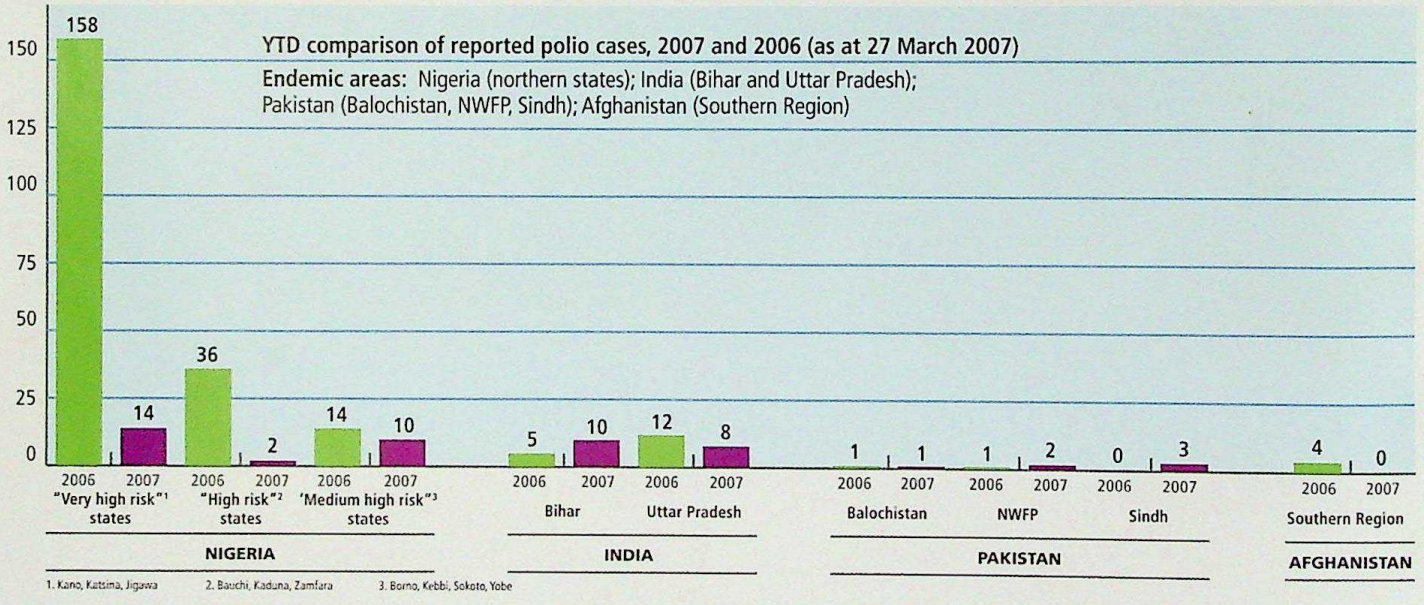


■ district infected with wild polio virus type 1*
■ district infected with wild polio virus type 3

* Excludes viruses detected from environmental surveillance and vaccine derived polio viruses

Data in WHO HQ as of 27 Mar 2007

Polio endemic areas



AFP and polio reporting, year-to-date comparison: 2006 and 2005

Source: Data at WHO as of 03 April 2007

WHO Region	AFP cases		Non-polio AFP rate		Adequate specimen rate		Wild polio virus cases	
	2006	2005	2006	2005	2006	2005	2006	2005
African	2'101	834	4.00	3.30	89%	85%	1'193	850
American	210	241	1.15	1.30	79%	79%	0	0
Eastern Mediterranean	1'685	1'414	3.89	3.69	89%	88%	108	727
European	225	301	1.05	1.10	82%	82%	0	0
South-East Asian	5'503	4'408	5.92	5.14	83%	83%	699	373
Western Pacific	176	353	1.70	1.65	88%	87%	0	0
Global	**9'900**	**7'551**	**3.63**	**3.34**	**85%**	**84%**	**2'000**	**1'950**

An up-to-date calendar of upcoming supplementary immunization activities in selected countries (previously featured in PolioNews) is now available in electronic format at: www.polioeradication.org/nid.asp

Respected Islamic leader Cheikh Hassan Cissé of Senegal supports polio eradication in Nigeria

Respected Islamic scholar Cheikh Hassan Cissé visited Nigeria in support of polio eradication activities in November 2006. Cheikh Cissé is the Chief Imam of the Grand Mosque in Medina Kaolack, Senegal, and one of the leaders of the Tariqa Tijaniyya – a Sufi brotherhood with a very large following in Africa and Nigeria. He is well know for his humanitarian activities in Africa in keeping with the teachings of Islam.

Cheikh Cissé embarked on a two-week tour of eight high-risk states across northern Nigeria, to impress upon communities the importance of polio immunizations, and to highlight the obligation of parents to protect their children against the disease.

During his visit, Cheikh Cissé met with political, traditional and religious leaders. Among others, the Cheikh met with His Eminence Alhaji Muhammad Sa'ad Abubakar III, the new Sultan of Sokoto, and the governors of all high-risk states, to stress the need for leadership to help finish polio in the country once and for all.

While addressing his followers at Quranic schools and mosques, Cheikh Cissé personally administered oral polio vaccine (OPV) to children.

Cheikh Hassan Cissé, respected Islamic leader from Senegal, immunizes a child against polio during his visit to Nigeria.

Tribute to ACPE member Aileen Plant

It is with great sadness that the Global Polio Eradication Initiative bids farewell to Dr Aileen Plant. Dr Plant passed away tragically and suddenly on 27 March, at Jakarta airport, on her way home from a World Health Organization meeting.

Dr Plant, a world-renowned epidemiologist and public health leader, was a member of the Advisory Committee on Polio Eradication (ACPE), the technical oversight body of the Global Polio Eradication Initiative. "It is with profound sadness that we learnt of the sudden passing of our dear colleague Dr Aileen Plant," said Professor Barry Schoub, fellow ACPE member from Johannesburg. "She was a very warm, friendly, compassionate, dedicated and insightful person, and she will be sorely missed. Our thoughts go out to her family and friends who we hope will draw some comfort from the esteem and high regard which her colleagues held for her."

More at www.polioeradication.org

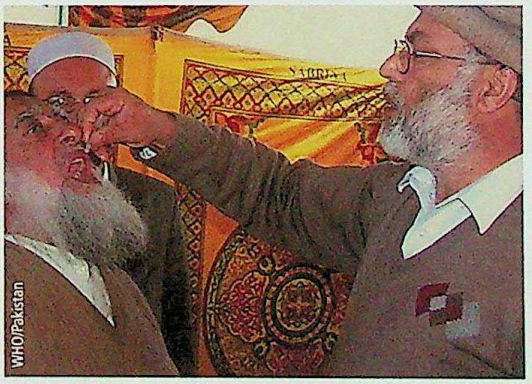
WHO Executive Board calls for full immunization of travellers from polio-affected areas

Standing recommendation under International Health Regulations to curb risk of international spread of polio

Although strong progress in stopping outbreaks in previously polio-free countries has been achieved in 2006, the poliovirus has repeatedly shown its ability to travel great distances, causing distant importations by either sea- or air-travel. To minimize the risk and consequences of potential future importations, countries should do more to protect themselves from re-infection.

Full immunization requirements of all travellers from any polio-affected area may be necessary in the near future. The Executive Board of the World Health Assembly, convening in January 2007 in Geneva, Switzerland, called for an appropriate standing recommendation under the International Health Regulations (2005), after their entry into force in June 2007. The issue will now be discussed at the upcoming World Health Assembly in May, in Geneva.

Already, individual countries are enforcing similar policies at national level. Saudi Arabia, for example, requires all Hajj travellers from Nigeria, India, Pakistan and Afghanistan to be immunized against polio.



Pilgrims to the Hajj from Peshawar, Pakistan, are immunized prior to their departure. Saudi Arabia requires all pilgrims from Nigeria, India, Pakistan and Afghanistan be immunized against polio. WHO's Executive Board has now called for universal immunization requirements.

International community: turning commitment into action

With political commitment to polio eradication underscored at the stakeholder consultation in Geneva on 28 February 2007 (see story on front page), key to success will now be to rapidly turn commitment into action. The 2007-2008 global funding gap stands at US$ 575 million.

To rapidly make available these funds, partners discussed the development of the 'Case for Finishing Polio Eradication' – a document outlining the public health and economic arguments for finishing the job. This document will be an essential tool for the donor community, to discuss at major international donor fora and in their capitals. The spearheading partners of the Global Polio Eradication Initiative are currently developing the 'Case' document, a first draft of which is expected by end-April 2007. The document is expected to be discussed with the international community in the margins of the upcoming World Health Assembly in Geneva, in May.

Filling the funding gap presents a financial challenge that will require unprecedented action on the part of both polio-affected and donor countries.

India Leads Way in Providing Domestic Resources to Help Finish the Job

On 28 February 2007, as partners met in Geneva at the urgent stakeholder consultation on polio eradication, the Minister of Finance of India stood up in Parliament and announced India's commitment to provide US$ 290 million in domestic resources for its 2007-2008 national polio eradication efforts. Increased domestic funding from the other remaining polio-endemic countries will be essential to ensuring planned activities take place. Pakistan is now exploring a major domestic contribution to cover the cost requirements of oral polio vaccine (OPV) for 2008-2010. Prime Minister Shaukat Aziz, who was briefed on the outcomes of the consultation, vowed that the government will not allow the children of Pakistan to become disabled because of this disease. Nigeria's Senior Special Assistant to the President on MDGs led the Nigerian delegation to the consultation. Nigeria is looking at using debt relief funding in support of Millennium Development Goal 4 (MDG4) to support its polio eradication efforts.

On 28 February 2007, Indian Finance Minister Shri Palaniappan Chidambaram announces domestic contribution of nearly US$290 million for polio eradication. The international donor community must now rapidly fill the remaining global funding gap of US$575 million for,2007-2008.

New External contributions*

All figures in US dollars

Austria	**US$ 750,000** for Ethiopia
Bill and Melinda Gates Foundation	**US$ 39.8 million** for Nigeria and surrounding countries
Central Emergency Relief Fund (CERF)	**US$ 500,000** for Democratic Republic of the Congo
Cyprus	**US$ 2,000** in global funding
Japan	**US$ 3.81 million** for OPV for Pakistan
Norway	**US$ 15.2 million** in global funding for 2006-2007
Oman	**US$ 100,000** in global funding
Spain	**US$ 940,000** for surveillance in several African countries
UNICEF National Committees	**US$ 325,000** from the Swiss Nat Comm for north Sudan
USAID/OFDA	**US$ 200,000** for Somaila

*Contributions received since *Polio News* 28.

The **Global Polio Eradication Initiative** expresses its gratitude to all donors.

Materials available

Also on www.polioeradication.org

Financial Resource Requirements for 2007-2009, January 2007 update

Conclusions and recommendations of the Advisory Committee on Poliomyelitis Eradication, Geneva, 11-12 October 2006, Weekly Epidemiological Record, 1 December & 8 December 2006

Forthcoming events

24-26 April 2007	Regional Certification Commission for the Eastern Mediterranean, Cairo, Egypt
27-28 April 2007	Horn of Africa Technical Advisory Group (TAG) for Polio Eradication, Addis Ababa, Ethiopia
14-23 May 2007	World Health Assembly, Geneva, Switzerland

World Health Organization · CDC · unicef

Polionews

All comments and feedback on Polio News should be sent to:
WHO, Geneva.
Tel.: +41 22 791 3219
Fax: +41 22 791 4193
Email: polionews@who.int
Web site: www.polioeradication.org

diseases, SARS seems to present a particularly serious threat to international health. Although SARS has a low mortality rate – 4 per cent – its clinical and epidemiological features remain poorly understood. Except for the Human Immunodeficiency Virus-Acquired Immune Deficiency Syndrome (HIV-AIDS), most diseases that emerged during the past two and a half decades, or became endemic in new geographical areas, have features that limit their capacity to pose a major threat to international public health. Diseases such as avian influenza, and those caused by the Nipah virus, the Hendra virus and the Hanta virus failed to establish efficient human-to-human transmission. Others such as Escherichia coli O157:H7 and variant Creutzfeldt-Jakob disease depend on the food chain for [illegible]smission.

Although outbreaks of the Ebola haemorrhagic fever have been associated with high fatality rates – 53 per cent in Uganda to 88 per cent in Congo – person-to-person transmission requires close physical exposure to infected blood and other bodily fluids. Moreover, patients suffering from this disease cannot undertake travel. In contrast, SARS, whose mode of transmission has been likened to that of Ebola, is emerging in ways that suggest great potential for rapid international spread. Epidemiological data indicate that the gestation period for SARS is two to 10 days (an average of two to seven days), which gives ample time for the infectious agent to be transported from one city to another through an asymptomatic air traveller.

The Indian case and that of a patient tr[illegible]'ling from Hong Kong to Vladivostok have highlighted the emergence of another international path for the virus, namely the sea-route. Since the foci of the disease seem to lie in the West Pacific rim, it is surprising that even the WHO had not considered this as an important epidemiological factor. Should SARS continue to spread, the global economic consequences – already estimated at around $30 billion – could be enormous.

However, the outbreak of SARS has demonstrated how well the WHO can tackle a newly identified disease. The international collaborative research effort in understanding the cause of SARS was put together by the WHO in record time. The WHO believes that the system, which is now in operation can be applied to other pandemic outbreaks, including the release of a biological agent in an act of warfare or terrorism. ■

PUBLIC HEALTH

A reluctant battle against polio

Uttar Pradesh accounts for 64 per cent of the polio cases reported worldwide, but its Chief Minister, Mayawati, is honoured with the Rotary International award for her "outstanding personal contribution" towards eradicating the disease from the State.

PURNIMA S. TRIPATHI

THE World Health Organisation (WHO) has described Uttar Pradesh as the "epicentre of polio epidemic" in the world. As per WHO estimates, the State accounts for 64 per cent of all polio cases reported worldwide. In comparison with 2001, the State registered a sixfold increase in the incidence of polio in 2002. According to the WHO, the sharp increase was because of a decrease in the number of polio eradication campaigns that year. Besides, the campaigns that were conducted failed to reach nearly 15 per cent of the targeted population.

Launching the third phase of the national pulse polio campaign on April 7, WHO Director-General Dr. Gro Harlem Brundtland said: "Eighty-three per cent of all new polio cases are now found in India. Uttar Pradesh, in particular, should be the number one priority in order to stop the transmission of the polio virus around the world."

According to WHO estimates, India's record in polio eradication is worse than that of countries such as Bangladesh. (Bangladesh has been declared 'polio free'.) India tops the list of seven countries, where polio is still widespread. India and Nigeria are the only countries that have registered increases in the number of polio cases. The other countries where polio is prevalent are Egypt, Pakistan, Afghanistan, Niger and Somalia.

According to the WHO, in 2002, the epidemic spread across northern India and to hitherto polio-free States such as Maharashtra, Gujarat and West Bengal. In January 2003, a child was paralysed by polio in Lebonan for the first time in nearly 10 years. Genetic sequencing of the virus confirmed that it originated from Uttar Pradesh, WHO sources said. According to Rotary International, even in Bulgaria, which was declared polio free, cases were reported in 2002, and genetic analysis of the virus revealed it was from Moradabad in Uttar Padesh.

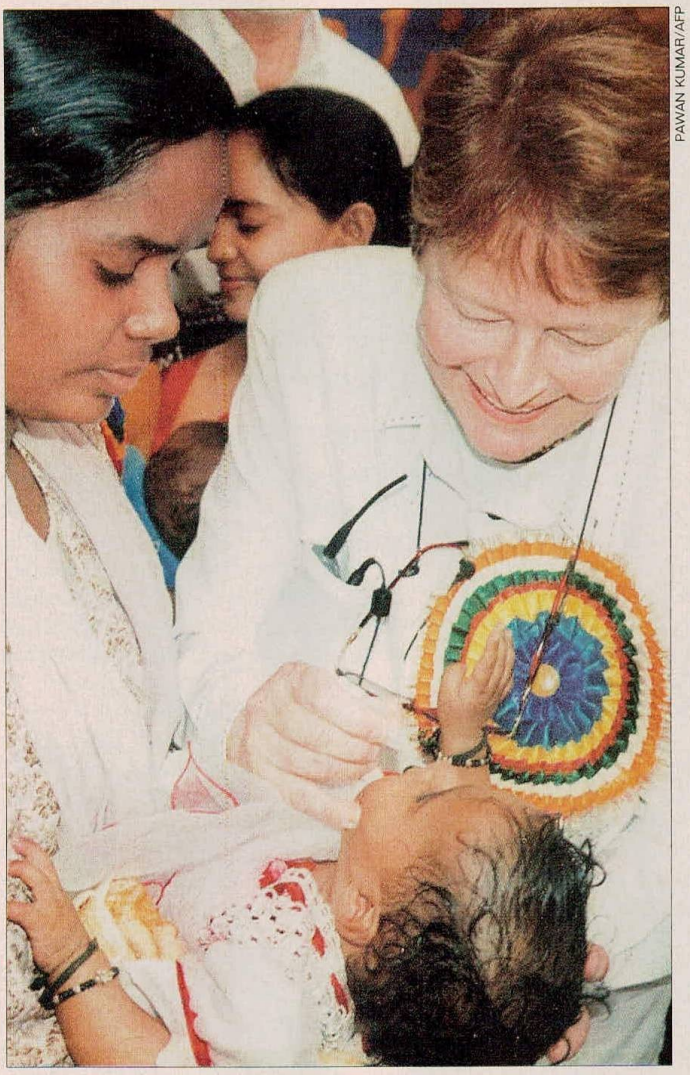
Given the State's poor record in dealing with the polio epidemic, it was rather surprising that Rotary International conferred the Paul Harris Fellow award on Chief Minister Mayawati for her "outstanding contribution" towards eradicating polio. The award, which includes a certificate, a gold medal and a Rotary pin, was presented to her by representatives of Rotary International and the United Nations Children's Fund (UNICEF), at her official residence on January 20. Mayawati, who became Chief Minister only in May 2002, said that eradicating polio would continue to be her government's priority. However, government officials seem to be at a loss for words when asked to elaborate on Mayawati's 'personal contribution' to eradicating polio. Even Rotary functionaries are unable to explain why the State had registered a sixfold increase in polio cases in 2002, despite the Chief Minister's "outstanding contribution".

A senior Rotary functionary, who has been associated with the pulse polio campaign, said the award had been conferred on the Chief Minister to "motivate" her to take more interest in the polio eradication campaign. A Rotary member said: "The increase has not been due to mismanagement at the government level. There are other factors responsible for it. One is the people's apathy to such campaigns, which lack credibility. Besides, misinformation about the polio vaccine being administered is also greatly responsible for the increase." According to him, an alarming factor was the resistance of people belonging to the minority

community, especially those from the lower income groups, to vaccinate their children. "Apparently, there is a belief that the polio vaccine causes impotency," he said. Religious leaders and prominent members of the community could help remove that, he said.

Other factors responsible for the resurgence of the epidemic in Uttar Pradesh are the high density of population and the lack of awareness about the pulse polio campaign. Extensive publicity campaigns, involving film and cricket personalities, have mitigated the opposition to a great extent, the Rotary official said. Although the exact numbers of those vaccinated would be known only after a few days, the third phase of the campaign had been successful when compared to the previous two, he said.

In association with the Rotary International, the UNICEF, the State and Central governments and non-governmental organisations, the WHO has planned six pulse polio campaigns in Uttar Pradesh for the entire year. According to WHO estimates, in the first two phases of the campaign, over 66 million children were immunised. Campaigns have been scheduled for June, September and November, and similar high-quality campaigns will be required in 2004 if the virus is to be eradicated.



PAWAN KUMAR/AFP

WHO Director-General Dr. Gro Harlem Bruntland administers a dose of polio vaccine to an infant at a function in Lucknow on April 6.

According to the WHO, as of April 1, 2003, 1,925 polio cases were reported from across the world. Eighty-five per cent of the cases are in India, nearly 75 per cent of them in Uttar Pradesh. As per WHO estimates, in India, 1,934 cases were detected in 1998; followed by 1,186 in 1999; 265 in 2000; and 211 in 2001. However, there was a stupendous increase last year, when 1,556 cases were reported in India, most of them in Uttar Pradesh.

In October 2002, Rotary International reinforced its polio eradication activities in India and brought in a grant of almost $5 million, taking its total contribution to more than $46 million. The grant helped meet the costs of hiring volunteers, including women, who would do a house-to-house vaccination campaign. In the current phase, over 80 million children across six States are expected to be vaccinated.

The resurgence of polio, especially its spread outside India has alarmed the world medical fraternity. "The support of the international community has never been more crucial than it is today," said Dr. Brundtland. "We need donors to fill the $275-million funding gap that we face globally, so that all activities can go ahead as planned. The generosity of the international community and the successful partnership that has been formed with polio-infected countries are crucial to ensure the success of this initiative," she said.

"We have 15 years of experience in polio eradication.... We have the tools and we have the strategies to finish this job. Today there is simply no moral or economic justification for any child anywhere in the world to be crippled by polio," Dr. Brundtland said.

The Central government is allocating more funds for the pulse polio programme. Against last year's allocation of Rs.4 billion, Rs.4.5 billion has been earmarked for this year. Dr. Daniel Tarantola, Director of Vaccines and Biologicals at the WHO, said: "This is an extraordinary epidemic. It requires an extraordinary effort by a whole range of national and international partners. After 15 years of progress, we are very focussed on India, where stopping transmission will be a monumental task."

Maria Calivis, Country Representative of UNICEF in India, said: "We're facing an enormous job. We have to stop polio in India. We all have to work together to reach every Indian child with polio vaccine and make sure that the vast numbers of children in Uttar Pradesh receive vaccine throughout 2003 and 2004. Beyond this programme, a huge effort is needed to ensure routine immunisation and quality primary health services. Today, most of India is polio-free and none of us want to see a reversal of the gains made in the past several years."

Worldwide, the polio eradication campaign is facing a shortfall of $275 million in funds; India alone needs $100 million. To counter this shortfall, Rotary International is intensifying its fund-raising efforts. It plans to raise $80 million by June 2003, in addition to the $500 million that Rotary has committed since 1985. "We will do everything in our power to ensure that nothing derails the dream of a polio-free world," said Bill Sergeant of Rotary International. "The international community must also step up efforts so that all children are protected from this tragic disease," he said. Sixty-five Rotary volunteers from around the world will travel to Uttar Pradesh and Delhi to administer the polio vaccine to children. ■

DIS-6.

Community Health Cell

From: indira chakravarthi [indirachakravarthi@yahoo.com]
Sent: Thursday, September 28, 2006 12:12 PM
To: JSA jsa
Subject: [pha-ncc] JSA & polio eradication programme

Friends,

This is regarding the pulse polio programme and the increase in the number of polio cases in UP.

From the newspaper reports since September 1st, what we get to know is:

1. According to our MoH&FW the programme has failed to deliver because of bad implementation; and the number of drop-outs in every round has been on the rise in UP.
2. According to WHO-UNICEF the reasons for western UP reporting a high incidence of polio are several – the most immediate ones are a slack government health machinery which simply missed covering many children, as well as localized pressures from muslim clergy spreading the canard among the most poor that the polio drops aims to reduce the community's fertility; and also lack of sanitation, and contamination of piped water by sewers.
3. According to WHO-UNICEF evaluation in April 2006, the coverage had deteriorated between late 2005 and early 2006, resulting in large number of children not receiving polio vaccine, although records said that the children had been vaccinated.
4. The UNICEF representative in UP denied that the muslims as a community resisted polio immunisation, and that it was the chief reason for the failure of the programme. Resistance was localised to a few places.
5. The MoHFW has set up a special committee to check cases of polio, which is to work in collaboration with NGOs. The Centre is to step up the fight against polio, with UP being the focus. There will be special awareness programmes among the muslims in UP.
6. ASHAs will be deployed for the purpose, and incentives maybe given to the vaccinators to ensure that the chain is not broken.
7. The government is thinking of introducing the injectable inactivated polio vaccine, as a pilot project in western UP.
8. Unlike UP the rest of the country is considered to have an excellent record, having completely eradicated the virus. UP is one of the few places where the wild polio virus still exists.
9. The health minister will go to Geneva to discuss the issue with WHO.

Several of us have, on the pha-ncc forum, expressed our concern and indicated that JSA should take it up – inform the general public, dialogue with the health authorities, based on specific demands force a correct policy decision, stop the polio eradication programme and revert to polio control, compensation for the VAPP cases, etc.

I have also put up several papers written by public health professionals, within and outside of JSA, **arguing out the problems with the very definition and concept of polio eradication, and the grave problem of vaccine associated paralytic polio. The IMA too, in May itself, has come out on the polio eradication programme.**

The media (in the name of objectivity and impartiality) has given us the above `information'. There is no mention of the fact that there are reservations/criticisms among public health professionals with the programme and the OPV, that it can and has caused paralytic polio, can revert to the neuro-virulent strain, etc.. The usual reasons of `bad implementation by government', `resistance by ignorant people' `poor sanitation' are being cited as the reasons for the `failure'. Can polio be eradicated at all by such means is a question that is not raised at all, or should not be raised in the media.

Some of us would probably be aware that at least one interview, of Abhay Shukla by the Mumbai NDTV, where he talked of the problems with the OPV and that it can cause paralytic polio, was not carried because the Head Office felt it was `being too critical of the government'. So much for our independent and democratic media!

Coming to the main point – I am once again re-iterating what some of us have already said last week on this group (and probably in other fora). JSA should come out and not just take a position. We should, either independently as JSA, or with some civil liberties group, or with the NHRC, take up a review of the entire programme in the context of this outbreak of polio cases; have a mass dissemination campaign, disseminate the correct information on the so-called `technical aspects', etc., and ask for the eradication programme to be stopped ~~altogether~~.

9/28/2006

Refs - Polio vaccine file
TN

To begin with – let us come out on this discussion group and say what we feel. Let us at least come out and say why we should/should not do it. Then, can we form a small sub-group, and start working on it? We already have sufficient information. We need to build on it.

Indira Chakravarthi
people's rural health watch - JSA

DIS-6

Global Polio Eradication Initiative in India
A Cause for Concern

Dr Onkar Mittal[1]
Dr C Sathyamala[2]

[**Abstract:** The paper suggests that the inability of the pulse-polio program to achieve polio eradication in India should surprise no one. This should not be misconstrued as a failure of a gigantic effort by lakhs of health workers and million of volunteers and participants in the program in the last eight years. The limitations of the efficacy of the oral polio vaccine and low routine immunization coverage in several parts of the state were well known to the WHO and all the other important decision-makers in the country. Despite this the case for early eradication of polio was aggressively promoted and the real possibility of failure was underplayed. The expensive gamble has however failed just as it happened in the past with other eradication programmes like malaria. Neither the global leaders of this initiative nor the Indian government are taking responsibility for this failure. The complete lack of transparency and accountability has meant that enormous amount of public resources, both in terms of money and manpower, has been wasted in this misadventure. The Global Polio Eradication Initiative illustrates the process of health policy making in the country and the role of international cooperation in health in the time of Globalization and Liberalization.)

[1] General Secretary, Society for Action in Community health (SACH), New Delhi.
E-mail: o_mittal@rediffmail.com.
[2] Epidemiologist; visiting professor, Centre of Social Medicine and Community Health, JNU, New Delhi.
E-mail: c_sathyamala@rediffmail.com.

Executive Summary

1. **The paper is an initial overview of the Global Polio Eradication Initiative (GPEI) in India.** It attempts to address three key issues arising from failure to meet the target of polio eradication in the country:

- How fair was it to impose the ambitious target of polio eradication on India, and other developing countries; a target which implies that a single case of polio anywhere would be tantamount to the failure of the entire global initiative? Could we have not managed better with less ambitious and more feasible target of polio reduction and control?
- Did we have a sound technical basis and operational strategy to embark on this super-ambitious polio eradication program? If yes, what went wrong with the implementation of this strategy?
- If the strategy of polio eradication initiative was faulty to begin with, what were the interests and influences that have played key roles in aggressively promoting this strategy in India and globally?

2. **Failure to achieve polio eradication in India despite eight years of intensive effort.** It is argued here that while the magic bullet of pulse polio and Intensive Pulse Polio Immunization (IPPI) might have contributed to the reduction of the transmission of poliovirus in India and other developing countries, it has singularly failed to achieve the eradication of polio. The first deadline of the year 2000 for achieving polio eradication has already passed. The new deadline of the year 2004 too is very close. In the high echelon of decision making, it is now agreed that this goal is not going to be achieved in the near future. Therefore the IPPI strategy has lost its meaning altogether and should be abandoned **immediately**.

3. The paper makes a plea for an independent review of the strategy from 2004 onwards to decide the future of the IPPI and other SIAs (Supplementary Immunization Activities) in India. There is an urgent need to learn lessons from the failure of the programme if we have to avoid repeating the same mistakes. This would also require a review of the lead role played by the international agencies like the WHO, UNICEF, Rotary International

and Centre of Disease Control (CDC), Atlanta, in order to avoid being misled by them in future.

4. **Real Magnitude of the Problem: Is polio eradication an overarching priority?** It is also argued that when the WHO launched the global polio eradication program in 1988, the estimates of polio cases in India (and globally) were perhaps gross overestimates. Considering that, currently, in India the confirmed polio cases amongst the reported (Acute Flaccid Paralysis) AFP cases are just 10-20 % of the total, the previous estimation of the paralyses attributed to polio virus requires a review. This has to be seen in the context of, how the proponents of the GPEI have admitted that polio eradication is not a priority for the developing countries. Yet the program has been justified on the grounds that it may result in small savings to the western countries which would no longer need to spend on vaccination once polio eradication is achieved globally. This is an unacceptable reason for over loading the already weak health systems of the developing countries to this exhausting marathon run. The billions of dollars spent on this program could have been more efficiently utilized to solve more pressing problems and in the rehabilitation of the decaying health systems of the developing countries. It calls for making a realistic exercise of estimation of the opportunity cost of implementing this program and opportunities lost in not implementing the more appropriate programs.

5. **Is it possible to repeat the great marvel of eradication of small pox?** The high optimism of repeating the success of small pox eradication with poliovirus too has been belied. There are several differences in the two situations. First, surveillance to determine whether and where smallpox virus was present was comparatively simple compared to polio surveillance and could be rapidly accomplished. The vast majority of patients with smallpox had a distinctive rash. There were no asymptomatic patients and no chronic carriers. Thus, it was possible to do this without recourse to a laboratory. With Polio, there are 200 or more asymptomatic infections for every paralyzed patient. The only way one can ascertain whether the virus continues to circulate in an area is by an extended period of surveillance during which a great number of stool specimens are examined. The second difference is with respect to the efficacy of vaccination. One inoculation of smallpox vaccine protected nearly 100% of those vaccinated. In contrast, OPV in now endemic areas requires at least 3 doses and often 5 or 6 doses to reach

protective levels of 90% for types I and III poliovirus, the predominant paralytic strains. Thus, in areas, where access and reach of vaccination programs was limited, vaccination immunity against smallpox could be rapidly increased because of the single dose inoculation but this is not possible with polio.

6. **Why did the WHO aggressively promote the case for eradication?** It is further argued that WHO over-pushed the case for eradication of poliovirus in India by using the example of Latin American countries that was not really applicable in the Indian situation. It also underplayed the real possibility of failures to achieve the goal due to well known limitations in India and other developing countries. These limitations pertained to the (i) very low routine immunization coverage in certain states in India and (ii) the low efficacy of the OPV in providing sufficient immunity in India and other developing countries. The WHO also overemphasized the possible benefits from the global eradication of poliovirus and underplayed the negative impacts on the general health services as well as the risks and costs of the failure of the program. It did all this against its own wisdom. It narrates how, after the failure of Malaria Eradication Programs globally, eradication became a 'bad word' in the WHO, notwithstanding the success achieved in small pox eradication earlier. It asserts, therefore that the WHO, in its organizational wisdom could not have, on its own, embarked on a global eradication program for polio. Based on the information available, it is difficult to figure out what influences have played a role in WHO for pushing polio eradication as an utmost urgent priority for the developing countries. We admit our failure in solving this riddle and invite others to help us in this endeavor.

7. The paper suggests that GPEI is yet another negative exercise in mismanaging the health priorities and programmes in developing countries. The UN institutions, their corporate philanthropic partners and the gullible health bureaucracies, technocracies and political leaderships of the developing countries, all are equal partners in this futile and absurd exercise. We also question the right of the G-8 nations and international philanthropies like Gates Foundation to provide earmarked resources for particular disease control programs and thereby distorting the health policies, priorities and programs of the developing countries. This appears to us as the biggest blemish on the international cooperation in health. Considering that global commitments are involved, it is necessary for India to play a more proactive role with the governments of the other

the last several years. The paper also calls for learning lessons from the entire GPEI for the functioning of WHO and the GPPP within the WHO.

8. **The way forward for India.** There is a great urgency to make critical decisions for strengthening the health systems in India. Only this can enable us to strengthen our routine immunization programme and achieve control of polio in due course. There is no shortcut to this process. The positive lessons should be drawn from the gigantic efforts made by lakhs of health workers and millions of volunteers and participants in the programme throughout the country. The programme should be publicized as a success in reducing the transmission of poliovirus in the country and not as a failure, just because some cases are still occurring. The live contact made with millions of poor and disadvantaged people for the first time by the country's health systems should be strengthened for health improvements in other areas and with involvement of the newly activated civil society.

9. **Right of compensation for those who have suffered from Vaccine Induced Paralytic Poliomyelitis (VIPP).** A considerable proportion of children who have developed AFP due to polio virus are those who have received 3 or more doses of OPV. There is need for comprehensive rehabilitation of those suffering from residual paralyses (due to poliovirus and other causes). In the current strategy these aspects find no place.

The inferences made in this paper are based on available information on the issue. It is perhaps not possible to avoid hasty conclusions and ideological biases while stimulating discussion and debate, especially while all the data and information has not been placed on the table. **We invite the readers and the experts in the field to place other facts and information on the table, challenge the inferences made in this paper and provide alternative interpretations and explanations.**

****

120th Session **EB120.R1**

Agenda item 4.1 **24 January 2007**

Poliomyelitis: mechanism for management of potential risks to eradication

The Executive Board,

Having considered the report on eradication of poliomyelitis,[1]

RECOMMENDS to the Sixtieth World Health Assembly the adoption of the following resolution:

The Sixtieth World Health Assembly,

Having considered the report on eradication of poliomyelitis;

Recalling resolution WHA59.1, urging Member States in which poliomyelitis is endemic to act on their commitment to interrupting transmission of wild poliovirus;

Recognizing that the occurrence of endemic poliovirus is now restricted to geographically limited areas in four countries;

Recognizing the need for international consensus on long-term policies to minimize and manage the risks of re-emergence of poliomyelitis in the post-eradication era;

Recognizing that travellers from areas where poliovirus is still circulating may pose a risk of international spread of the virus;

Noting that planning for such international consensus must commence in the near future,

1. URGES all Member States where poliomyelitis is still prevalent, especially the four countries in which poliomyelitis is endemic:

(1) to establish mechanisms to enhance political commitment to, and engagement in, poliomyelitis eradication activities at all levels, and to engage local leadership and members of the remaining poliomyelitis-affected populations in order to ensure full acceptance of, and participation in, poliomyelitis immunization campaigns;

---

[1] Document EB120/4 Rev.1.

(2) to intensify poliomyelitis eradication activities in order rapidly to interrupt all remaining transmission of wild **poliovirus;**

2. URGES all Member States:

(1) to protect against importations and international spread of wild polioviruses by reviewing and, if appropriate, updating national policy to recommend full immunization against poliomyelitis for travellers to areas in which poliovirus is circulating;

(2) to revise national policy and legislation on immunization of travellers from countries in which poliovirus is circulating in accordance with temporary or standing recommendations which may be established under the International Health Regulations (2005) once they enter into force;

(3) to reduce the potential consequences of importation of wild poliovirus by achieving and maintaining routine immunization coverage against poliomyelitis greater than 90% and, where appropriate, conducting supplementary poliomyelitis immunization activities;

(4) to strengthen active surveillance for acute flaccid paralysis in order rapidly to detect any circulating wild poliovirus and prepare for certification of poliomyelitis eradication;

(5) to prepare for the long-term biocontainment of polioviruses by implementing the measures set out under phases 1 and 2 in the current edition of the WHO global action plan for laboratory containment of wild polioviruses;[1]

3. REQUESTS the Director-General:

(1) to continue to provide technical support to the remaining Member States where poliomyelitis is still prevalent in their efforts to interrupt the final chains of transmission of wild-type poliovirus, and to Member States at high risk of an importation of poliovirus;

(2) to assist in mobilizing financial resources to eradicate poliomyelitis from the remaining areas where poliovirus is circulating, to provide support to countries currently free of poliomyelitis that are at high risk of an importation of poliovirus, and to minimize the risks of re-emergence of poliomyelitis in the post-eradication era;

(3) to continue to work with other organizations of the United Nations system on security issues, through mechanisms such as "days of tranquillity", in areas where better access is required to reach all children;

(4) to initiate the process for a potential standing recommendation, under the International Health Regulations (2005), on the immunization against poliomyelitis of travellers from areas where poliovirus is circulating;

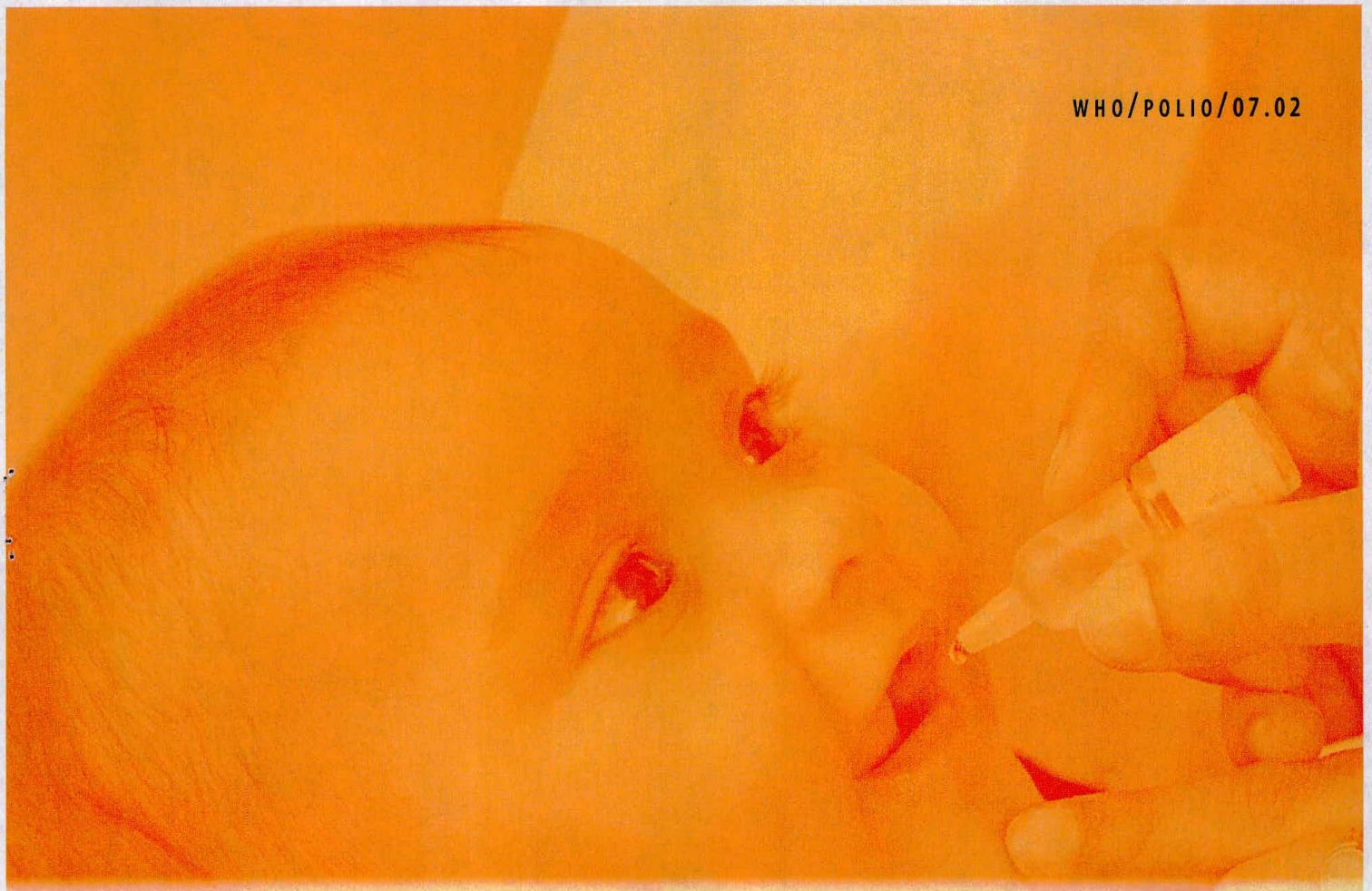
[1] Document WHO/V&B/03.11 (second edition).

(5) to submit proposals to the Sixty-first World Health Assembly with a view to minimizing the long-term risks of reintroduction of poliovirus or re-emergence of poliomyelitis in the post-eradication era, by establishing international consensus on the long-term use of poliomyelitis vaccines and biocontainment of infectious and potentially-infectious poliovirus **materials.**

Fourth meeting, 23 January 2007
EB120/SR/4

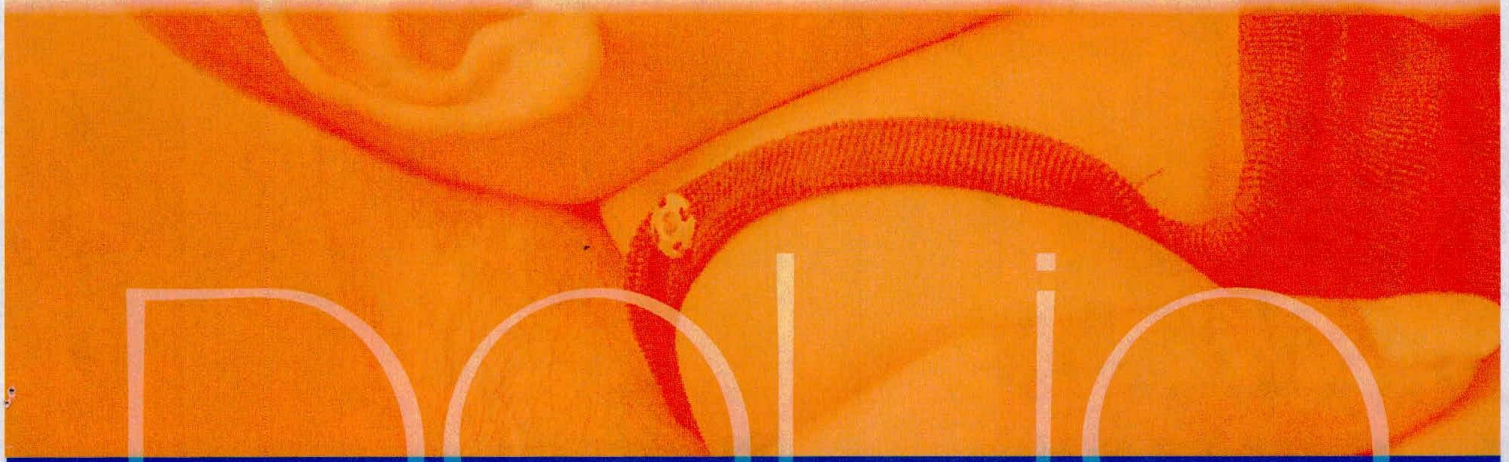
= = =

WHO/POLIO/07.02



ANNUAL REPORT 2006

GLOBAL POLIO ERADICATION INITIATIVE



POLIO

DRAFT VERSION FOR WHA

For your final print copy, please send an email to polionews@who.int or drop your business card in the box at the Global Polio Eradication Initiative stand."

World Health Organization

CDC

unicef

WHO document reference: WHO/Polio/07.02

Copies may be requested from:
World Health Organization
20 Avenue Appia
CH-1211 Geneva 27, Switzerland
Fax: +41 22 791 1571
email: polioepi@who.int

Photo front cover: A child is immunized in Bihar, India. © UNICEF/Ravi Kumar Gupta.
Design and layout: L'IV Com Sàrl, Morges, Switzerland.

Printed in Switzerland.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The year 2006 began with the confirmation that indigenous wild poliovirus transmission had been stopped in Egypt and Niger, reducing the number of endemic* countries to a historic low of four. In the remaining countries – Afghanistan, India, Nigeria and Pakistan – intensification of immunization campaigns succeeded in geographically restricting virus transmission by the end of 2006.

The number of countries which had never stopped indigenous polio was reduced to a historic low of four.

In response to rising number of cases in the early part of the year, by May Nigeria rolled out "Immunization Plus Days", adding other health interventions to polio vaccination campaigns and leading to improved coverage. Aggressive immunization response to a large outbreak in India made the outbreak far smaller than in previous years: analysis of the vaccination status of cases showed that children over two years of age were well-vaccinated, enabling a focus on the youngest children, to whom the 'immunity gap' is now limited. New epidemiological studies showed that unique demographic and sanitation conditions in northern India make trivalent oral polio vaccine less effective there than elsewhere, informing a decision to use the more efficacious monovalent vaccine on a larger scale.

The sustained poliovirus circulation between Pakistan and Afghanistan, aided by the frequent movement of people across a porous border, sparked closer synchronization of vaccination campaigns and activities at crossing points. In Afghanistan, President Hamid Karzai took close oversight of polio eradication activities, prompted in part by an outbreak in the Southern Region during the first part of the year which was exacerbated by deteriorating security.

The Advisory Committee on Polio Eradication re-affirmed the technical and operational feasibility of polio eradication.

Only 10 of the 26 countries re-infected since 2003 were still reporting polio transmission in the second half of 2006, following rapid and intense immunization response. An important success was the end of the Indonesia and Yemen outbreaks, the largest in numbers. By the end of the year, high-risk outbreaks from imported virus were limited to central Africa, the Horn of Africa and Bangladesh.

Based on the progress in 2006, the Advisory Committee on Poliomyelitis Eradication (ACPE), which provides independent technical counsel to the Global Polio Eradication Initiative, re-affirmed in October the technical and operational feasibility of polio eradication. The ACPE noted that success depended on the remaining four countries, which now have the best tools available to complete eradication: the more potent monovalent oral polio vaccine (mOPV) to boost immunity faster than before and laboratory procedures which halve the time needed to confirm poliovirus and allow for a rapid immunization response.

* Countries that have never interrupted indigenous wild poliovirus transmission are referred to as endemic throughout this report.

The national technical advisory bodies of the four endemic countries convened in December 2006, to recommend new and tailored approaches for 2007 to overcome the specific operational challenges in each of these last four endemic areas. Success now hinges on rapidly raising the levels of vaccination coverage and immunity in the areas with endemic transmission to at least those levels attained in the polio-free areas of these countries.

With polio geographically more restricted than ever before, and equipped with new-generation tools and tactics, the world now has the best-ever opportunity to assign this ancient scourge to the history books definitively, providing there is a collective global will and sustained political commitment from the highest levels. Instrumental to success will be full implementation of the targeted new approaches, high-quality operations and the continued support of donors, most notably in urgently filling the global funding gap of US$ 540 million for 2007–2008 (as of May 2007).

Equipped with new-generation tools and tactics, the world now has the best-ever opportunity to assign this ancient scourge to the history **books.**

KEY EVENTS

In 2006, partners in the Global Polio Eradication Initiative vaccinated **375** million children during **187** immunization campaigns in **36** countries, with **2.1** billion doses of vaccine.

January

Egypt and Niger confirm interruption of indigenous polio.

Bangladesh suffers importation of virus after five polio-free years.

February

Indonesia and Yemen outbreaks are stopped.

March

Outbreak begins in Uttar Pradesh state in India, peaking in September.

April

Fire in Mumbai polio laboratory necessitates reassignment of staff and stool samples.

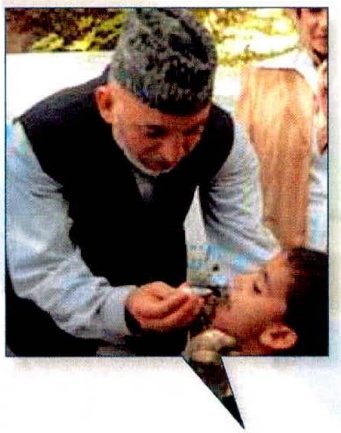
May

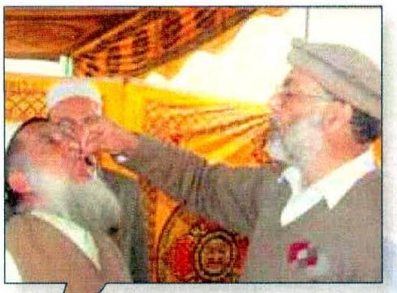
Eradication loses a champion at the death of WHO Director-General LEE Jong-wook.

June

Outbreak from imported virus in Namibia is stopped in 50 days by following new outbreak response guidelines endorsed by World Health Assembly in May.

2006





July

Lab network launches procedures to halve poliovirus confirmation time.

August

Outbreak in Southern Region of Afghanistan is exacerbated by deteriorating security situation. In response to the outbreak, Afghan President Hamid Karzai launches National Polio Action Group

September

High-risk outbreaks continue in the Horn of Africa, central Africa and Bangladesh.

October

ACPE re-affirms feasibility of polio eradication.

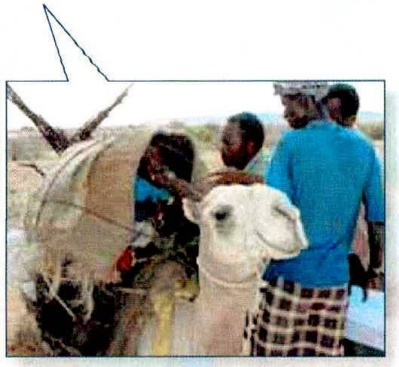
November

Saudi Arabia begins requiring vaccination of travellers from polio-endemic countries.

Research published in *Science* magazine indicates monovalent OPV can boost immunity enough to stop polio in northern India.

December

While most of the territory of each endemic country is polio-free, tailored strategies are adopted in remaining endemic countries to raise immunity levels among children in the endemic areas to those in the polio-free areas.



STRATEGIC OBJECTIVES

3.1 INTERRUPTION OF POLIOVIRUS TRANSMISSION

Progress in polio eradication is measured against milestones set out in the *Global Polio Eradication Initiative Strategic Plan for 2004-2008*. The strategic objectives outlined in that plan form the foundation for eradication:

1. interruption of wild poliovirus transmission
2. global certification of eradication
3. development of products for potential OPV cessation
4. mainstreaming of the Global Polio Eradication Initiative.

The milestones set for each strategy are periodically reviewed and amended as necessary as per recommendations by the Advisory Committee on Poliomyelitis Eradication (ACPE), which provides independent technical counsel to the Global Polio Eradication Initiative.

MILESTONES 2006

MILESTONE 1: NO COUNTRIES WILL BE POLIO-ENDEMIC AT THE END OF 2006.

STATUS: **NOT ACHIEVED** — Four areas of four countries remain polio-endemic. Transmission of endemic poliovirus is now concentrated in northern Nigeria, two states of India (Bihar and Uttar Pradesh), and border areas of Pakistan and Afghanistan.

Egypt and Niger are no longer polio-endemic. The ACPE in October 2006 reaffirmed that the global eradication of wild poliovirus is both technically and operationally feasible and concluded that the four remaining endemic countries now have the best tools ever to rapidly achieve polio eradication.

MILESTONE 2: ALL PLANNED SUPPLEMENTARY IMMUNIZATION ACTIVITIES (SIAs) WILL BE IMPLEMENTED IN HIGHEST-RISK POLIO-FREE AREAS.

STATUS: **ACHIEVED** — SIAs were implemented as planned in Bangladesh, Benin, Cameroon, Chad, Nepal and Niger.

Highest-risk polio-free areas are those bordering endemic reservoir areas (re-infected areas are considered under outbreak response below).

MILESTONE 3: 50% OF COUNTRIES WILL ACHIEVE GAVI ALLIANCE TARGETS FOR DTP3/OPV3.

STATUS: **ACHIEVED (2005 DATA)** — 43/72 (60%) of GAVI Alliance-eligible countries had national DTP3/OPV3 coverage greater than 80%; 22/72 (30%) of countries had national DTP3/OPV3 coverage greater than 90%.

The GAVI Alliance target calls for all countries to have greater than 80% routine immunization coverage in every district and 90% routine immunization coverage nationally by the year 2010. In 2005, 7/72 (10%) of GAVI Alliance-eligible countries had reached this target.

MILESTONE 4: ALL EMERGENCY MOP-UPS WILL BEGIN WITHIN FOUR WEEKS OF CASE CONFIRMATION.

STATUS: **PARTIALLY ACHIEVED** — Emergency mop-ups were conducted within four weeks of case confirmation in 5/6 (83%) importation events in 2006.

Cameroon, the Democratic Republic of the Congo (DR Congo), Kenya and Namibia conducted activities within four weeks of case confirmation. Bangladesh conducted activities within 39 days of case confirmation.

Note: In Chad, a late-2006 case was reported in January 2007, and an emergency mop-up was conducted within four weeks of confirmation. Additionally, emergency outbreak response activities continued in a number of countries with ongoing transmission of imported polioviruses from 2005, e.g. Angola, Ethiopia, Nepal, Niger and Somalia.

MILESTONE 5: ALL NON-CERTIFIED COUNTRIES WILL HAVE CERTIFICATION-STANDARD SURVEILLANCE.

STATUS: **PARTIALLY ACHIEVED** — 61/76 (80%) of non-certified countries have met certification-standard surveillance targets[1].

The following countries did not meet the required standards: Algeria, Bhutan, Cyprus, Djibouti, Gabon, Guinea-Bissau, Kuwait, Lebanon, Malawi, Maldives, Morocco, Saint Helena, Sri Lanka, Timor Leste and United Arab Emirates.

[1]Excludes island nations with populations less than 300,000, e.g. Comoros, Mauritius, Reunion, Sao Tome and Principe and Seychelles.

COUNTRIES WITH INDIGENOUS POLIO: TAILORED STRATEGIES MONITORED BY TOP POLITICAL LEADERSHIP

The world's success in eradicating polio now depends on four countries – Nigeria, India, Pakistan and Afghanistan – according to the Advisory Committee on Polio Eradication (ACPE), meeting in October 2006. These countries have at their disposal the best set of technical tools in the history of eradication.

Transmission of indigenous poliovirus is geographically restricted to limited areas of these four countries, in specific populations. In December 2006, all four countries convened national technical advisory body meetings to outline local tactics for reaching all children under five years of age with vaccine enough times to protect them from polio.

EGYPT AND NIGER REMOVED FROM ENDEMIC COUNTRY LIST

In January 2006, Egypt and Niger were removed from the list of polio-endemic countries, reducing the number of remaining countries with indigenous polio transmission to an all-time low of four. Neither country has experienced indigenous circulation of wild poliovirus since January 2005.

NIGERIA: "IMMUNIZATION PLUS DAYS" LEAD TO PROGRESS IN LATTER HALF OF 2006

In December 2005, President Olusegun Obasanjo of Nigeria set the tone for polio eradication activities in the following year, mandating the Ministry of Health and the National Programme on Immunization (NPI) to eradicate polio and strengthen routine immunization.

The number of cases of polio in Nigeria in 2006 rose to 1,124 from 830 in 2005. As the first quarter of the year signalled a three-fold rise in numbers over the same period in 2005, the Expert Review Committee for Polio Eradication (ERC) – Nigeria's technical advisory body – endorsed a strategy of 'Immunization Plus Days' (IPDs) in March 2006. Launched by the new management of NPI in May, IPDs offer other antigens and health interventions to communities in addition to OPV. Since the introduction of IPDs, the proportion of children in northern states who had never been immunized was reduced to an average of 20% (from more than 50% at end-2005). The number of new cases dropped after June: fewer than a third of Nigeria's cases in 2006 occurred in the second half of the year.

The proportion of never-immunized children in northern states fell from over 50% to an average of 20%.

Nigeria: Risk classification by state

NIGERIA

KEY POINTS 2006

- Presidential mandate for polio eradication
- New strategy of Immunization Plus Days recommended by Nigeria's Expert Review Committee on Polio Eradication
- Increase in number of children reached in northern states
- Decrease in new cases in second half of year

FOCUS FOR 2007

- Build on progress achieved in 2006 through IPDs
- Use risk-classification to target Kano, Katsina and Jigawa states as 'very high risk' for ongoing polio transmission
- Further engage all communities
- Ensure all activities are state-driven

Key to success: reduce the number of 'missed children' to <10% in Kano, Katsina and Jigawa

AFRICAN UNION COMMISSION HELPING TO "KICK POLIO OUT OF AFRICA"

At the end of 2006, indigenous polio in Africa was restricted to Nigeria, as most of the countries re-infected in 2003-05 had successfully stopped polio transmission or were close to doing so. Political leadership from the Chairperson of the African Union Commission, Professor A.O. Konaré and the strong support of the Union's Social Affairs Commissioner was important to this development.

Chairperson Konaré reviewed the progress of polio eradication in Africa on a quarterly basis with the World Health Organization, and actively advocated with the Heads of State of polio-affected countries. He also encouraged donor nations, especially the G8 and the EU member states to continue their financial support to ensure the success of this historic effort on the continent.

The IPDs have also proven popular with local communities and political leadership. 'Community Dialogues' organized in key areas before IPDs give community members the opportunity to ask questions about polio eradication efforts and have given rise to a nascent sense of ownership by civil society.

The new approach does not come without drawbacks, not the least of which is financing. Operational costs are 60% more than polio-only supplementary immunization activities. This level of cost is difficult to sustain and demands new sources of funding. The IPDs are also operationally complex to manage, straining the health infrastructure in the north of the country. The availability of the additional vaccines, vitamins and medications that are offered is erratic due to weaknesses in operational planning or deficiencies in stock.

The ERC re-convened in December 2006 to analyse local strategies to overcome local challenges. Each geographical area was classified by the level of risk of poliovirus transmission, to enable states to better prioritize their activities. Kano, Katsina and Jigawa states – which accounted for 60% of the country's cases in 2006 – were classified as 'very high risk' due to ongoing coverage gaps of greater than 25% during IPDs. Key to successfully eradicating polio in Nigeria will be to urgently reduce the proportion of missed children in very high risk states to less than 10%.

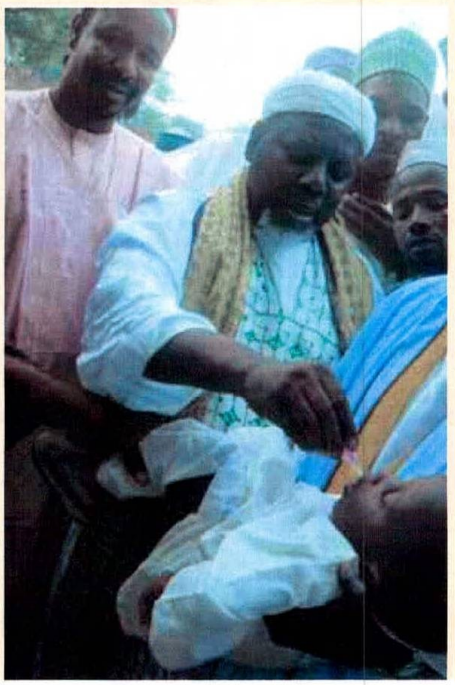
SPIRITUAL LEADER REMINDS COMMUNITIES OF THE OBLIGATION TO PROTECT CHILDREN

Cheikh Hassan Cissé, a spiritual leader with followers across western Africa, embarked in November 2006 on a two-week tour of eight high-risk northern Nigerian states to impress upon communities there that polio immunization is a religious obligation of parents, in keeping with the teachings of Islam to protect children from disease. This tour took place at the request of the Secretary-General of the Organization of the Islamic Conference.

During this extraordinary mobilization campaign, the Cheikh, who is the Grand Imam of Medina Kaolack in Senegal, travelled most nights and met by day with Governors, Emirs and religious leaders and scholars. He addressed vast gatherings of his followers in all the major cities of the area and visited Quranic schools and mosques to speak with parents and religious leaders, quoting from the Holy Quran and the Hadith to underscore "the need for protecting children, as they are the future," as he put it.

In press conferences, the Cheikh encouraged members of the media to communicate his message that Islamic teachings advocate for immunization. Coverage of his sermons and speeches was broadcast on and printed in local and international media.

At the end of the tour, President Olusegun Obasanjo invited Cheikh Cissé to the capital to express his gratitude and appreciation for the Cheikh's efforts.



Cheikh Hassan Cissé, respected spiritual leader, immunizes a child against polio during his visit to Nigeria.

INDIA:

OUTBREAK IN NORTHERN INDIA, BUT IMMUNITY GAP LIMITED TO UNDER-TWO YEAR-OLDS

In India, an outbreak originating in the western end of Uttar Pradesh state resulted in the re-infection of polio-free areas of the country and a ten-fold increase in new polio cases in 2006 over the previous year (674 cases, compared to 66 cases in 2005).

The outbreak occurred primarily due to a drop in vaccination campaign quality and children being missed in late 2005 and early 2006. The Government of India reacted with swift improvements in vaccination campaign coverage in the highest-risk areas. This response, coupled with wide-spread use of monovalent oral polio vaccine type 1 (mOPV1), resulted in 60% fewer cases than India's most recent outbreak in 2002.

Epidemiological research published in November showed that trivalent OPV is less effective at protecting children from polio in northern India than in the rest of the country or other parts of the world, due to the unique demographic, health and sanitation conditions prevalent in Uttar Pradesh and Bihar. The research vindicated the large-scale use of mOPV in these areas and indicated that immunity levels of children there would have to be boosted with more intense vaccination activities before they could reach the levels reached in other parts of India.

In addition, analysis of the epidemiological and programmatic data from the 2006 outbreak revealed that 73% of children affected were less than two years old, showing that mOPV had effectively immunized older children. The programme could now concentrate on reaching the youngest children more frequently, so that they would have more doses of mOPV before the age of two than previous birth cohorts.

Armed with the vaccine efficacy research and this immunological profile, the India Expert Advisory Group on Polio Eradication (IEAG), which provides independent technical counsel to the programme, recommended in December 2006 a tactical refinement to close the immunity gap in the youngest age group.

Launched in early 2007, the approach calls for sharply increasing the number of large-scale supplementary immunization activities (SIAs) in the highest-risk districts of western Uttar Pradesh and Bihar and focusing on children aged less than three years of age. Large-scale SIAs with mOPV1 will be held on average every four weeks, supplemented by the administration of a dose of mOPV1 at birth.

Full implementation of this strategy is expected to close the immunity gap in the youngest children in Uttar Pradesh and Bihar states and to raise immunity levels in these areas to levels above those in the rest of India.

INDIA

KEY POINTS 2006

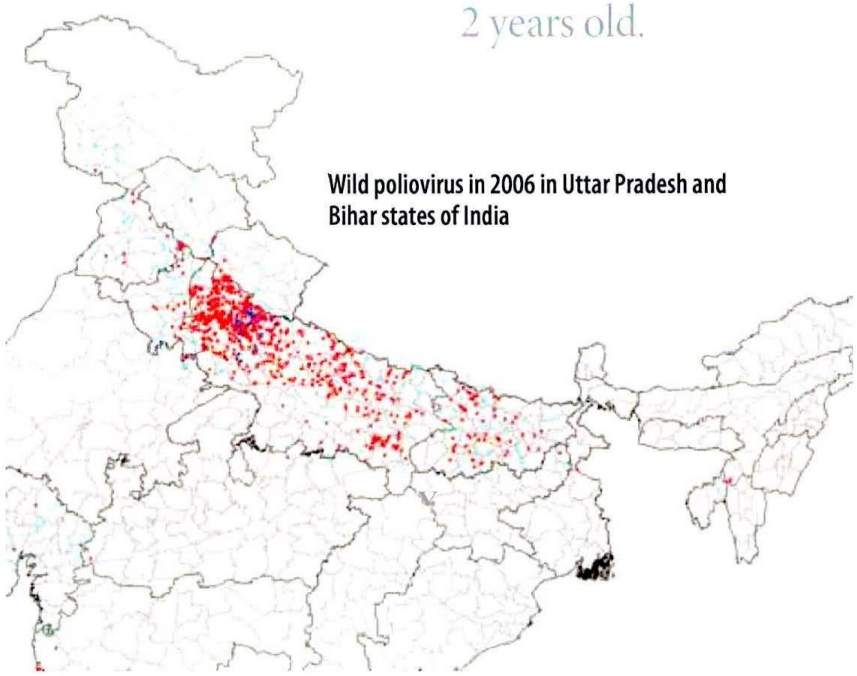
- Bihar and Uttar Pradesh only remaining endemic states
- Outbreak originating in western Uttar Pradesh results in ten-fold increase in cases
- Immunity gap reduced to children under two years old

FOCUS FOR 2007

- Increase frequency of supplementary immunization activities to rapidly close immunity gap
- Focus on youngest children in high-risk districts of western Uttar Pradesh and Bihar
- Maximize each contact through expanded use of monovalent OPV type 1

Key to success: raising and maintaining immunity levels above the levels in polio-free parts of India

Despite the outbreak, new monovalent OPV significantly reduced the last immunity gap, in children less than 2 years old.



Wild poliovirus in 2006 in Uttar Pradesh and Bihar states of India

More than 200 Rotarians from Canada, Europe and the United States joined thousands of their counterparts in India and in African countries to immunize children against polio during numerous supplementary immunization activities in 2006.

A humanitarian service organization that has made polio eradication its top philanthropic goal, Rotary International is a spearheading partner in the Global Polio Eradication Initiative and is committed to the cause until global certification.

To that end, Rotary members around the world, including those based in the endemic and high-risk countries, donate their time and personal resources to raise funds and volunteer in the field. During mass immunization campaigns, Rotarians regularly administer the drops of oral polio vaccine, staff immunization posts, deliver the vaccine to remote villages and educate families on the importance of protecting every child against polio.

"Until polio is eradicated worldwide, every child remains at risk," said Anil Garg, US team leader of a group that travelled to his homeland of India. "Preventing paralysis from polio in just one child has major social and economic consequences for the victim, family and entire country."

Through its PolioPlus program, established in 1985, Rotary was the first to have the vision of a polio-free world, and continues to play a crucial role in global efforts to eradicate polio. More than one million Rotary members have volunteered to protect more than two billion children in 122 countries from polio. Rotary provides urgently needed funds: to date, the organization has contributed more than US$ 616 million to eradicate polio. In addition, Rotary has played a major role in decisions by donor governments to contribute more than US$ 3 billion to the effort.

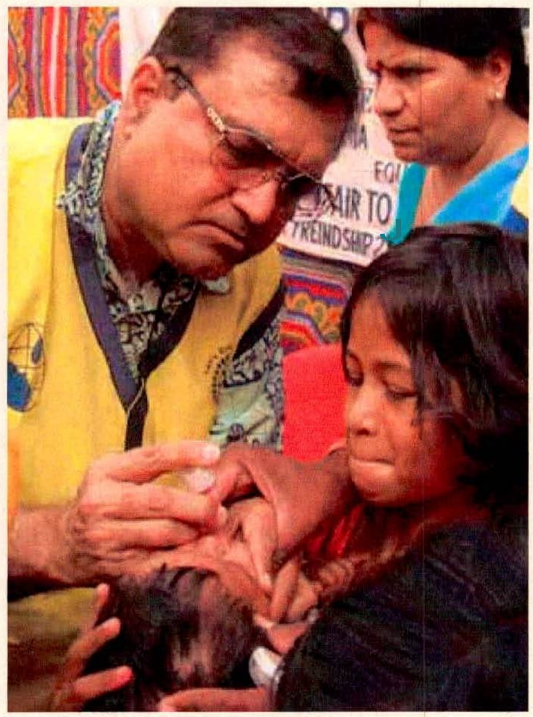


PHOTO © ANIL GARG

Rotarian Anil Garg of Simi Valley in the USA. Born and raised in Delhi, India, Garg has led numerous polio immunization trips to India and has also provided Tsunami relief.

PAKISTAN

KEY POINTS 2006

- Most of the country polio-free
- Polio transmission sustained in mobile or socially conservative communities and in insecure areas
- Corridor of cross-border transmission with Afghanistan

FOCUS FOR 2007

- Increase cross-border coordination with Afghanistan to close immunity gap
- Strengthen federal and provincial political ownership of polio eradication
- Improve access to tribal agencies

Key to success: fully coordinating activities with Afghanistan to increase access to hard-to-reach populations

PAKISTAN:
CLOSE BILATERAL COORDINATION NEEDED TO STOP POLIO AS VIRUS LARGELY LIMITED TO BORDER AREAS

Of the remaining areas which have yet to stop polio, the single epidemiological block represented by Pakistan and Afghanistan stands to achieve eradication most rapidly. In 2006, even though the number of polio cases rose to 40 (from 28 in 2005), transmission in Pakistan was limited to a handful of clearly-identified areas, largely along the Afghan border. These include the corridors between southern and eastern Afghanistan and Pakistan's North West Frontier Province (NWFP) and Balochistan.

The interruption of transmission in 80% of the districts in Pakistan testifies to the solidity of the overall strategies of mass vaccination campaigns to reach every child repeatedly to boost immunity. The vast majority of polio cases in 2006 came from previously identified zones of transmission in NWFP, Balochistan and Sindh. In a demonstration of the impact of mOPV1, no type 1 polio cases have been reported from reservoir areas in northern Sindh since 2005 and southern Punjab since July 2006.

In some of the high-risk areas, most notably the Federally Administered Tribal Areas in NWFP and some areas of Balochistan, access to communities is compromised by security risks. While efforts to overcome this constraint are ongoing, further mechanisms are needed to improve access in these areas. In 2006, work focused on the identification of and access to mobile populations and engagement with the semi-autonomous tribal communities and their leaders.

In a joint technical meeting between Pakistan and Afghanistan, held in Oman in December 2006, advisers recommended closer cooperation between the two countries. The Ministers of Health of both countries met that same month at the Torkham border post and agreed on specific steps, including an increase in the numbers of immunization posts at formal crossings points – to vaccinate children who are travelling – and the establishment of regular inter-ministerial meetings to coordinate planning. After the meeting, each minister crossed the border and administered OPV to children in the neighbouring country.

Polio was largely limited to a shared corridor of transmission along the common border.

Successfully eradicating polio in Pakistan depends on implementing a multi-pronged strategy to reach children in mobile groups, to involve conservative and semi-autonomous tribal communities and to synchronize vaccination campaigns carefully with Afghanistan in order to clear the border of poliovirus. A significant affirmation of national and provincial commitment will be vital to the effective implementation of this strategy.

AFGHANISTAN:
OUTBREAK IN SOUTHERN REGION CONTAINED DESPITE SECURITY CHALLENGES

Most of Afghanistan is today polio-free, but the country suffered an outbreak in the Southern Region due to sustained cross-infection with Pakistan, with which it forms a single epidemiological block. Cases in Afghanistan increased from 9 in 2005 to 31 in 2006.

The outbreak in the Southern Region was exacerbated by deteriorating security conditions – making it perilous for health workers to move around and vaccinate children – but contained by intense vaccination activities which exploited every opportunity within the constraints of the conflict. By year-end, the outbreak had been contained within the region and Afghanistan was closer to polio eradication than any of the other three endemic countries.

In tandem with the fluctuating security situation, polio teams worked with various sectors of society at the district, state and national level to negotiate increased access to children. More local community members were recruited as vaccinators and supervisors. Teams took advantage of any opportunity when areas could be accessed to conduct rapid and focused mop-up activities, in addition to the planned large scale vaccination rounds. In August, the President of Afghanistan Hamid Karzai established a National Polio Action Group to align and strengthen national and provincial oversight of these activities.

Indigenous transmission of endemic poliovirus is sustained in Afghanistan among mobile groups – whether nomadic, displaced or seasonally migratory – and in communities who live in insecure or socially conservative areas. The poliovirus that straddles the Afghanistan-Pakistan border circulates among and with these communities. The movements of the mobile communities were mapped more systematically in 2006 and long-term immunization posts set up at key migrant gathering areas and known border crossings between Afghanistan and Pakistan.

AFGHANISTAN

KEY POINTS 2006

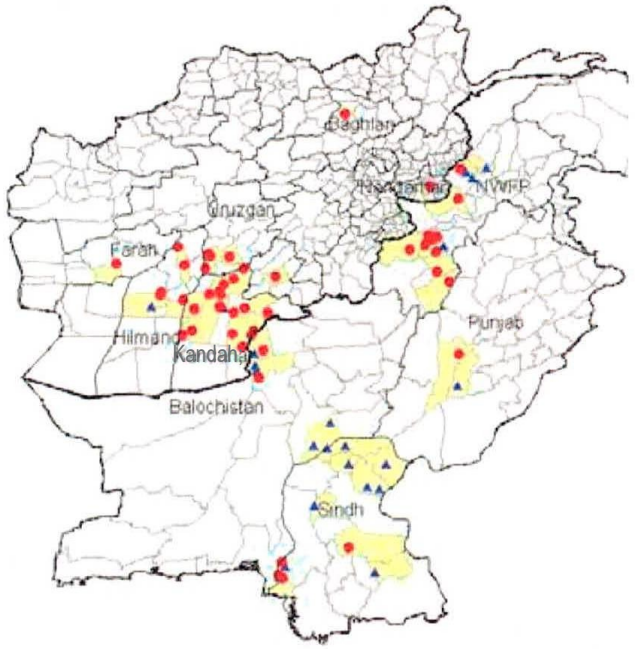
- Most of the country polio-free
- Polio transmission sustained in mobile or socially conservative communities and in insecure areas
- Corridor of cross-border transmission with Pakistan

FOCUS FOR 2007

- Increase cross-border coordination with Pakistan to close immunity gap
- Sustain political ownership of polio eradication at national and provincial levels
- Exploit any improvement in security conditions by coordinating with relevant actors

Key to success: fully coordinating activities with Pakistan to increase access to hard-to-reach populations

Wild poliovirus in 2006 in Afghanistan and Pakistan



To rapidly close the immunity gap among these "hard-to-reach" populations, in December 2006 independent technical advisers for Pakistan and Afghanistan, meeting in Oman, recommended that both surveillance and SIAs be increasingly coordinated between the two countries. In one of their first actions after this, Ministers of Health of both countries jointly addressed a historical health *jirga* of tribal leaders to advocate for the latters' support and the participation of their communities in reaching each child with vaccine.

Successfully eradicating polio in Afghanistan now depends on exploiting any positive security developments, on tighter coordination of activities with Pakistan and on continued top-level oversight at the federal and provincial levels to make sure no child is missed.

AFGHANISTAN: PRESIDENT TAKES OVERSIGHT OF POLIO ERADICATION

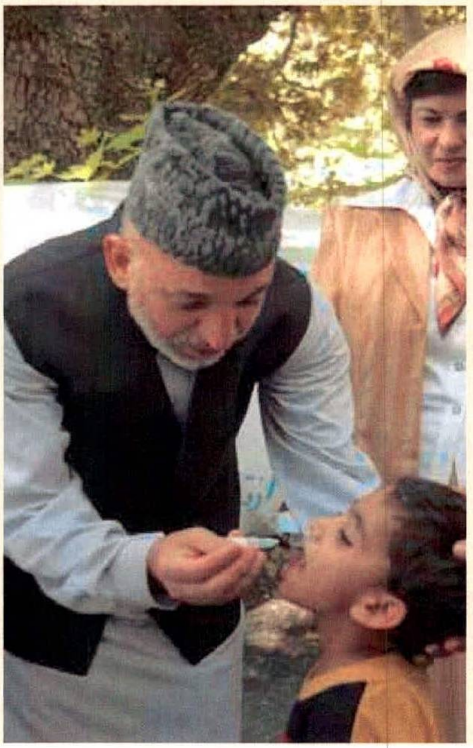
The most significant chain of wild poliovirus in this region straddles the Afghan-Pakistan border and caused an outbreak in 2006 in Afghanistan's Southern Region. Deteriorating security in the region presented immediate hazards for health workers attempting to vaccinate children in the area, exacerbating the outbreak. To align the response in the provinces concerned, President Hamid Karzai established a National Polio Action Group in August, tasking governors in the Southern Region to oversee the development and implementation of plans to increase access to all populations.

Polio eradication in the Southern Region focused on three immediate objectives:

- **To ensure the safety of staff working in the field.**
- **To maintain the highest levels of continuity of operations possible, given the deteriorating situation.**
- **To ensure that polio transmission did not re-infect other areas of Afghanistan.**

Polio teams used any window of opportunity to access districts in security-compromised areas, while continuing large-scale campaigns in other regions to maintain high-population immunity levels.

With these efforts, polio eradication remained one of the few public health initiatives to maintain operations in the Southern Region in 2006, and the outbreak was contained. Other areas of Afghanistan were protected from re-infection, and by the end of the year only three cases had been reported outside the Southern Region, one of which was on a frequently-travelled area on the border with Pakistan's North West Frontier Province.



President Hamid Karzai vaccinates an Afghan child.

PHOTO © EPI AFGHANISTAN

RE-INFECTED COUNTRIES: NEW RESPONSE GUIDELINES SHORTEN OUTBREAKS

2006 was a testing ground for the effectiveness of new outbreak response guidelines, adopted by the World Health Assembly in May (Resolution WHA59.1). Of the 26 countries re-infected with importations of poliovirus since 2003, only 10 continued to report polio cases in the second half of 2006. An outbreak in June in Namibia, following an importation of Indian virus via Angola, affected mostly adults and caused a number of deaths. Using the outbreak response guidelines and vaccinating the entire population several times, officials limited the outbreak to a record 50 days from first case to last. Indonesia and Yemen, which suffered the largest, single country epidemics in recent years, succeeded in stopping their respective outbreaks in the first two months of 2006. As a result, re-infected countries only accounted for 6% of all polio cases in 2006, down from more than 50% of cases in 2005.

The focus for 2007 will be on rapidly stopping the high-risk outbreaks where polio transmission continues: in central Africa (Angola and the Democratic Republic of the Congo), the Horn of Africa (Ethiopia, Kenya and Somalia) and Bangladesh. Areas contiguous to endemic countries are also at heightened risk until the interruption of transmission in the latter.

Re-infected countries accounted for 6% of all polio cases in 2006, down from more than 50% in 2005.

PHOTO © WHO ETHIOPIA/DR TAJUDIN

Polio immunization of a nomadic child in Somali region, Ethiopia: 2006 witnessed rapid progress in stopping outbreaks in re-infected countries, but active polio transmission continues in Angola, Bangladesh, the Democratic Republic of the Congo, Ethiopia, Kenya and Somalia.

NEW RESPONSE GUIDELINES SHORTEN POLIO OUTBREAKS

The World Health Assembly, where WHO Member States set global health policies, adopted in May 2006 a resolution with clear guidelines for polio-free countries to respond to importations of virus.

Given the ease with which poliovirus travels, the risk of importation is very real as long as the virus circulates anywhere in the world, and the guidelines are designed to minimize both this risk and the consequences of an importation. The main characteristics of the response are:

- **It is rapid and creates an emergency plan – a rapid investigation within 72 hours of confirmation of a case to establish an emergency plan of action;**
- **It is swift and sustained – a minimum of three large-scale rounds of immunization with type-specific vaccine, the first of which starts within four weeks, with at least two campaigns after the last case;**
- **It is large-scale – targeting at least two million children aged less than five years in the affected and adjacent geographical areas;**
- **It is high quality – house-to-house campaigns where applicable and independent monitoring to determine whether immunization coverage is at least 95%; with higher-than-standard surveillance for acute flaccid paralysis for the duration of the outbreak and at least 12 months thereafter and high routine immunization coverage.**

PHOTO © T. FIGUIRA/UNICEF

Swift and massive vaccination campaigns such as this one, targeting the entire population, shut down the Namibia outbreak within 50 days.

3.2 SURVEILLANCE AND CERTIFICATION OF GLOBAL POLIO ERADICDATION

Confirming that transmission of wild poliovirus is stopped depends on solid surveillance and is followed by certification for polio-free regions that have maintained the necessary levels of surveillance. Recognizing the delays in detecting transmission of poliovirus in some areas in 2003-04, the surveillance target for acute flaccid paralysis (AFP) detection rates* has been doubled since 2005 in high-risk areas. To this is added the strength of new laboratory procedures that halve the confirmation time for **poliovirus.**

MILESTONES 2006

MILESTONE 1: PERCENTAGE OF NON-CERTIFIED COUNTRIES WITH CERTIFICATION-STANDARD SURVEILLANCE: 100%.

STATUS: **PARTIALLY ACHIEVED** — 97% of non-certified countries have certification-standard surveillance (the exceptions are Algeria, Guinea Bissau, Bhutan, East Timor, Djibouti and Lebanon).

MILESTONE 2: PERCENTAGE OF AFP SPECIMENS PROCESSED IN A WHO-ACCREDITED LABORATORY 100%.

STATUS: **ACHIEVED** — All AFP specimens were processed in a WHO-accredited laboratory.

MILESTONE 3: PERCENTAGE OF COUNTRIES COMPLETING PHASE I LABORATORY BIO-CONTAINMENT PHASE: 100%.

STATUS: **PARTIALLY ACHIEVED** — 75% of polio-free countries have completed Phase I activities, including all countries of the WHO European Region.

MILESTONE 4: PERCENTAGE OF COUNTRIES SUBMITTING 'FINAL' CERTIFICATION DOCUMENTATION: 85%.

STATUS: **80%** of eligible countries submitted final documentation for certification.

AFP SURVEILLANCE SENSITIVITY CONTINUES TO CLIMB

The very high sensitivity and reliability of AFP surveillance was sustained and even further improved in 2006. All WHO regions, including those already certified as polio-free (the Americas, Western Pacific and European Regions), maintained AFP surveillance at or substantially above 'certification quality' (see Table 1).

Continued sensitive AFP surveillance in polio-free countries is critical in order protect to countries from importations of poliovirus and to enable swift outbreak response if necessary. The Regional and National Polio Certification Commissions assist countries and regions striving to maintain or achieve polio-free status.

[1]Certification-standard surveillance is defined as the ability to detect at least one case of non-polio AFP for every 100,000 children under 15 years of age, to collect two adequate stool specimens from at least 80% of cases of acute flaccid paralysis and to process all specimens at a WHO accredited laboratory.

Table 1: Quality of AFP reporting by WHO Region in 2005 and 2006[2]

WHO Region	Reported AFP cases		Non-polio AFP rate		% AFP with adequate specimens	
	2005	2006	2005	2006	2005	2006
African Region	11 683	12 478	3.3	4.0	86	89
Americas	2 213	2 154	1.3	1.1	80	79
Eastern Mediterranean Region	8 849	8 740	3.7	3.9	88	89
European Region	1 479	1 550	1.1	1	82	82
South-East Asian Region	31 530	36 631	5.4	5.9	82	83
Western Pacific Region	6 680	6 873	1.7	1.7	88	88
Global total	62 434	68 426	3.3	3.6	84	85

AFP surveillance quality in all three endemic regions, already well above certification standards, further increased in 2006. The total number of non-polio AFP cases reported from the African (AFRO), Eastern Mediterranean (EMRO) and South-East Asian (SEARO) Regions increased from 52,062 in 2005 to 57,849 in 2006, mainly due to heightened surveillance and resultant increases in AFP reporting in the four large remaining endemic countries in those regions: Afghanistan, India, Nigeria and Pakistan. The sheer increase in AFP cases reported in 2006 in these regions led to overall non-polio AFP rates of 3 or more per 100,000 – as the vast majority of AFP cases turn out to be caused by conditions other than polio after stool analysis. All three regions also recorded increases in the second important surveillance quality indicator, the percentage of AFP cases with collection of adequate stool specimens.

AFP surveillance quality in all three endemic regions, already well above certification standards, further increased in 2006.

A country-by-country analysis of AFP surveillance quality shows improvements in the great majority. The proportion of countries which reached a level of AFP reporting of 2 or more per 100,000 in the two endemic regions with the greatest disease burden increased from 62% to 75% of countries in AFR and from 54% to 63% of countries in SEAR.

A limited number of countries in each endemic region did not reach certification quality AFP surveillance. These include Algeria and Guinea Bissau in AFRO, Bhutan and East Timor in SEARO, and Djibouti and Lebanon in EMRO. A few other countries in EMRO achieved AFP indicators just below the 'certification cut-off' and are considered to have maintained certification-quality AFP surveillance: Morocco, United Arab Emirates, Lebanon, and the Occupied Palestinian Territories.

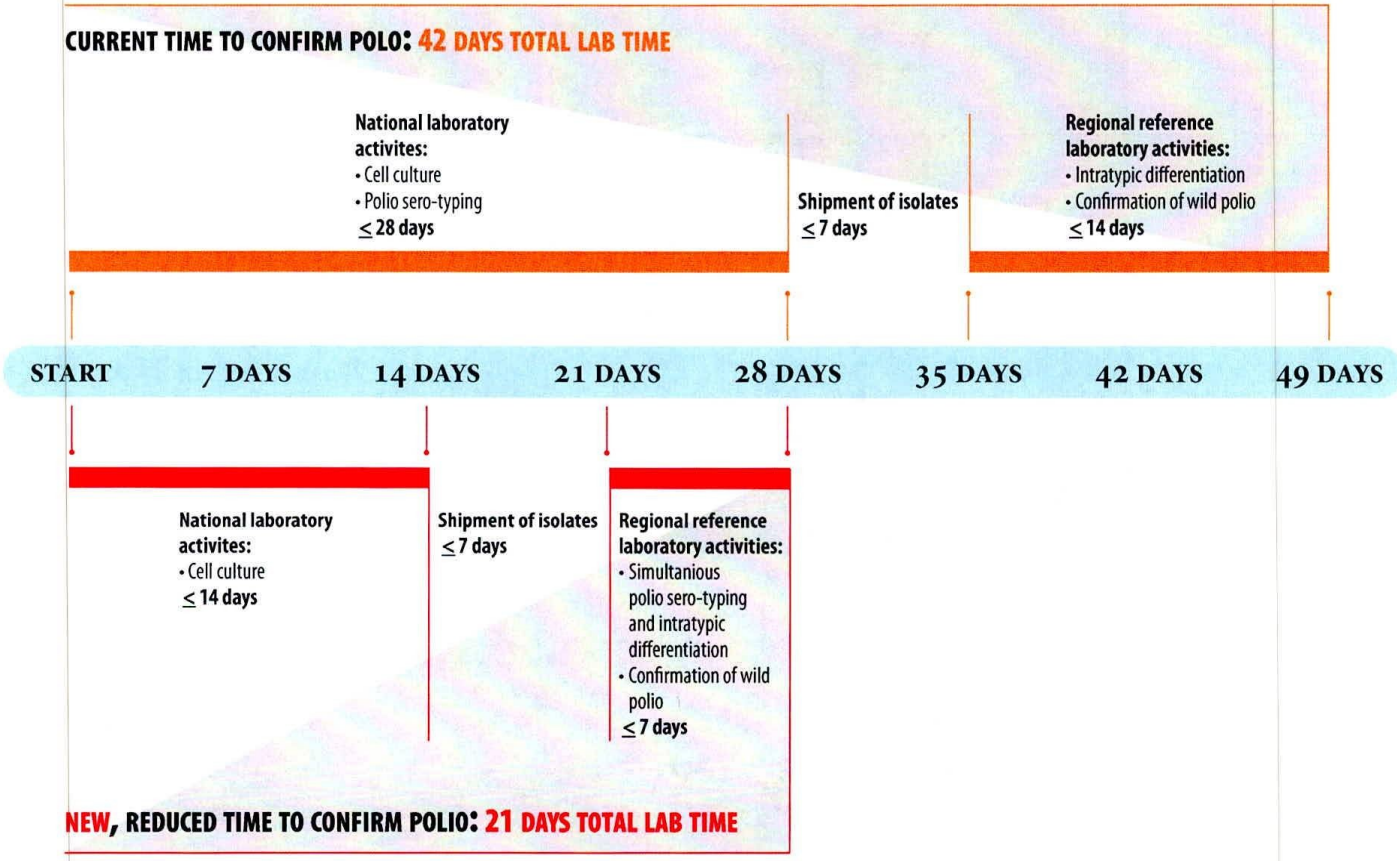
[2]2006 data as of 17 April, 2007.

LAB NETWORK CONFIRMS VIRUS TWICE AS FAST

Laboratory results are used to confirm the presence of poliovirus, to plan immunization responses and to monitor progress towards achievement of the eradication goal. Rapid and accurate laboratory results are paramount to these goals. A global network of 145 laboratories continues to support AFP surveillance. The network's quality assurance programme incorporates a WHO-administered accreditation program involving annual (usually on-site) evaluation of facilities and procedures, results of proficiency tests, timeliness and accuracy of results. Ninety seven per cent of laboratories were fully accredited in 2006, and all samples from AFP cases were tested in accredited laboratories with arrangements for parallel testing of samples from poorly performing laboratories where necessary.

The laboratory network's workload in 2006 was approximately 125,000 faecal samples from 63,000 AFP cases and 8,600 non-AFP samples. The workload for investigated AFP cases was 25% higher than that of 2005. Wild polioviruses were isolated from AFP cases in 16 countries in 2006.

Genetic characterization of isolates showed that indigenous viruses were transmitted in four countries (Afghanistan, India, Nigeria and Pakistan). Five countries had continued transmission of imported viruses introduced in 2005 (Angola, Ethiopia, Indonesia, Somalia and Yemen), while other countries had new importations (Bangladesh, Cameroon, Chad, Namibia, Nepal, Niger, Kenya, DR Congo). Viruses in five countries (Angola, Bangladesh, DR Congo, Namibia and Nepal) were genetically linked to India viruses, while all other importations linked directly or indirectly (via transmission in intermediate countries) to Nigeria.



In 2006 the laboratory network evaluated, and subsequently adopted, a new testing strategy that reduces poliovirus confirmation time within laboratories by 50% (from 42 days using the traditional approach to 21 days) without compromising poliovirus detection sensitivity. The new approach involves use of technologies that are already available within the network but in a different algorithm (i.e. sequence of testing). The strategy was evaluated in reference laboratories in Atlanta in the USA, Islamabad in Pakistan and Mumbai in India. Approximately 5,200 faecal samples, including 900 poliovirus positive samples, were tested during the field evaluation. It is estimated that the new strategy will increase cell culture costs by 25% and intratypic differentiation (ITD) costs by 100%.

In 2006 the laboratory network evaluated, and subsequently adopted, a new testing strategy that reduces poliovirus confirmation time within laboratories by 50%.

Key to achieving faster results will be testing of samples in laboratories with capacity for both virus isolation in cell cultures and intratypic differentiation (of viruses as wild or vaccine like) using polymerase chain reaction (PCR) and Enzyme Linked Immunosorbent Assay (ELISA). The network has established a goal of testing at least 75% of faecal samples from polio endemic regions in laboratories with such capacities by December 2007. This will require upgrading of 11 existing national laboratories to perform ITD tests with implications for investing in capital equipment, reagents and staff training. Staff training has already begun. An ITD training workshop was held in Uganda in November 2006 for participants from eight network laboratories. Additionally staff of four existing ITD laboratories of South East Asia were oriented on the requirements of the new test strategy in April 2006.

The network suffered a serious setback in 2006 when fire destroyed the sequence unit at the global specialized laboratory in Mumbai, India, and caused damage to the cell culture unit and office areas within the facility. The impact included: loss of equipment; closure of the laboratory for cleaning and renovation; re-directing of

PHOTO © WHO/F. PALADIN

Participants from eight polio network laboratories are trained in Uganda in November 2006, on use of the new protocol which halves the time required to confirm the presence of ***poliovirus****.*

over 10,000 faecal samples and 6,000 polio isolates to 2 other network laboratories (situated in Lucknow and Chennai, India) for testing; loss of 15 trained staff who obtained jobs elsewhere; suspension of testing of sewage samples collected in Mumbai; suspension of Mycoplasma testing of cell cultures used in 16 laboratories in South East Asia; and long delays in obtaining sequence data on polioviruses from India. At year-end, sequencing was being performed in Mumbai at a non-network laboratory that generously offered part-time access to its equipment. The Mumbai polio laboratory is expected to become fully functional by mid-2007 following completion of renovation works.

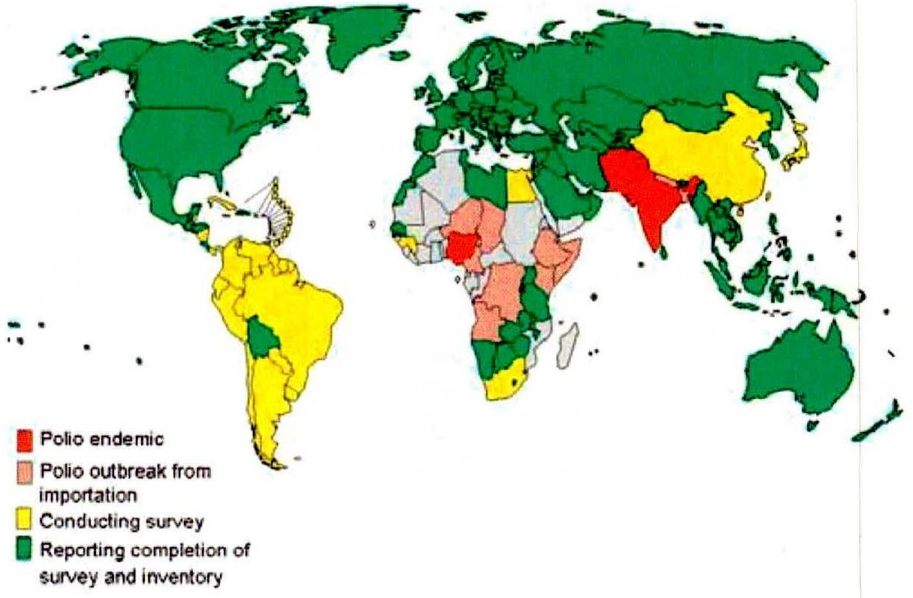
NOTABLE PROGRESS ON CONTAINMENT PREPARATIONS FOR POLIOVIRUS

Laboratory containment remains an integral part of polio eradication activities in all six WHO Regions. In 2006, regional and sub-regional meetings on laboratory containment were held to either monitor progress with Phase I implementation or review documentation from countries reporting completion of the **work.**

Over 75% of all polio-free countries have completed Phase I containment activities.

Notable progress towards completion of Phase I was reported from China, central America, and eastern and southern Africa. China has successfully completed a thorough survey of all facilities falling under the jurisdiction of the Ministry of Health, with plans to complete the survey of remaining facilities in 2007. Similarly, Mexico reported expanding its initial survey of facilities to include an additional 50,000 laboratories throughout the country. In southern and eastern Africa, all polio-free countries either submitted a report on the completion of the activities to the Regional Certification Commission at their meeting in 2006 or report that the process is ongoing.

Progress with Phase I of Global Containment



In WHO regions with a large number of countries which previously completed the Phase I activities, work continues to ensure that complete documentation on the process is reviewed by Regional Certification Commissions (RCCs). EMR conducted such a review for the 16 countries which reported completion of Phase I. Countries were requested to submit standardized information which was first reviewed by WHO and subsequently by independent experts. The results will be made available to the RCC at their meeting in **2007.**

The Phase I laboratory containment activities work towards the objective of identifying facilities with poliovirus materials and raising awareness of the need for containment of polioviruses once eradication is achieved. To date, over 75% of all polio-free countries have completed Phase I activities, including all countries of the WHO European Region.

INCREASE IN NUMBER OF COUNTRIES SUBMITTING FINAL CERTIFICATION DOCUMENTS

National Polio Certification Committees (NCCs) and Regional Certification Commissions (RCCs) in endemic Regions continued to scrutinize in detail national documentation to show polio-free status submitted by eligible* countries. The number of eligible countries for which RCCs accepted final certification documentation increased from 10 to 14 in AFR (of 46 Member States), and from 6 to 8 in SEAR (of 11 Member States); it remained steady at 15 of 22 Member States in EMR because several countries, including Sudan, were re-infected after they had already had successfully submitted final certification documentation. The percentage of total WHO Member States which successfully submitted final certification documentation increased slightly from 78% in 2005 to 80% in 2006.

*Eligible countries are those where no wild poliovirus has been found for at least three years, in the presence of certification quality surveillance. Countries can file documentation but cannot receive polio-free certification, which can only be conferred on a WHO Region as a whole.

3.3 DEVELPOMENT OF PRODUCTS FOR POTENTIAL GLOBAL OPV CESSATION

The current risk posed by wild polioviruses remains far greater than the risk of vaccine-associated paralytic polio (VAPP) or circulating vaccine-derived polioviruses (cVDPVs). However, after interruption of wild poliovirus transmission, Sabin vaccine viruses could continue to cause individual paralysis or outbreaks. Consequently, as recommended by the ACPE, the Global Polio Eradication Initiative undertakes a programme of work for the identification, reduction and management of the potential risks associated with the cessation of OPV, whether the re-emergence of polio due to a cVDPV or re-introduction of either a wild or Sabin poliovirus. Progress on these strategies and related products are detailed in the section below.

MILESTONES 2006

MILESTONE 1: CESSATION OF OPV FOR ROUTINE IMMUNIZATION: CONSOLIDATE OPV CESSATION STRATEGY AND NATIONAL IPV DECISIONS.

STATUS: **PARTIALLY ACHIEVED** — Research is ongoing in a variety of settings to determine the scope and nature of the risks and risk mitigation options associated with OPV cessation and use of inactivated polio vaccine (IPV).

MILESTONE 2: DETECTION AND IMMEDIATE NOTIFICATION OF CIRCULATING POLIOVIRUSES: INCORPORATE POLIO SURVEILLANCE INTO INTERNATIONAL HEALTH REGULATIONS (2005) AND THE GLOBAL OUTBREAK AND ALERT RESPONSE NETWORK.

STATUS: **ACHIEVED.**

MILESTONE 3: POLIO VACCINE STOCKPILES AND EMERGENCY RESPONSE: LICENSURE OF AT LEAST TWO mOPV SUPPLIERS.

STATUS: **ACHIEVED.**

MILESTONE 4: LONG-TERM CONTAINMENT OF POLIOVIRUS STOCKS: FULLY ALIGN WITH SECURITY PROCESSES FOR SIMILAR PATHOGENS.

STATUS: **ACHIEVED.**

Bio-risk management standard developed in consultation with those responsible for bio-containment of smallpox and experts in bio-safety and risk management.

IDENTIFICATION OF RISKS ASSOCIATED WITH OPV CESSATION

As our knowledge of VDPVs continues to evolve, a better understanding of the risks they pose to polio eradication has become a priority of the Global Polio Eradication Initiative. In terms of identifying and defining these risks, the focus is currently on: modelling of VDPV risk associated with OPV cessation; further defining VDPV prevalence among immuno-deficient persons (iVDPVs) in middle- and low income countries; and analysing poliovirus isolates emanating from the global acute flaccid paralysis (AFP) surveillance system and other sources.

iVDPV STUDY SERIES

A known potential source of VDPVs are people suffering from primary immune deficiencies (PIDs) who excrete vaccine-derived polioviruses (iVDPV). It has been recognized that the risk of circulating VDPVs (cVDPVs) will eventually be reduced over time once OPV is no longer in use; however the risk of iVDPVs is likely to persist as long as there are persons excreting iVDPVs.

Thirty-two persons shedding iVDPVs have been reported to WHO since 1962. All of the iVDPVs identified to date have been reported from upper- or middle-income countries. Although most of the reported iVDPVs have spontaneously stopped poliovirus excretion or died, at least four have reported excretion for more than five years. Limited data are available on the prevalence and natural history of prolonged or chronic poliovirus excretion among persons with PIDs in middle- and low-income countries, and whether this population may serve as an important reservoir of VDPVs in these countries is unknown. To address the knowledge gaps associated with the incidence and behaviour of iVDPVs, as well as to increase local capacity for the surveillance and monitoring of iVDPVs, the Global Polio Eradication Initiative has begun planning a study series to generate information regarding the prevalence of PIDs with long-term poliovirus excretion in low- and middle-income countries currently using OPV.

After interruption of wild poliovirus transmission, Sabin vaccine viruses could continue to cause individual paralysis or outbreaks.

LABORATORY ANALYSIS OF VDPVs

During 2006, the laboratory network detected Vaccine Derived Polioviruses (VDPVs) in a number of locations, including:

- Locations with evidence of person-to-person spread: Nigeria (type 2 VDPVs from 16 AFP cases in 4 different provinces), China (type 1 VDPV from 1 AFP case and 8 community contacts in Gaunxi), Myanmar (type 1 AFP case and 7 contacts); Cambodia (type 3 VDPV from 1 AFP case following isolation of a genetically related VDPV from an AFP case with onset in late 2005).
- VDPVs from AFP cases with follow up investigations pending: Syria (a single type 2 case)
- VDPVs detected in sewage waters without paralyzed persons found during follow up investigations: Czech Republic (10 type 1 VDPVs); Israel (2 type 2 VDPVs).
- VDPVs (type 2) in an immuno-deficient person from Tunisia, the case having been detected in **France.**

REDUCTION OF RISKS ASSOCIATED WITH OPV CESSATION

Reducing the potential risks of OPV cessation involves the preparation for containment of all polioviruses in a post-eradication world and the demonstration of the scientific and logistic feasibility of producing inactivated vaccine based on Sabin rather than wild poliovirus. Additional projects include the development of products such as rapid diagnostics and antiviral compounds against polioviruses.

CONTAINMENT OF POLIOVIRUSES

In 2006, the plan for long-term containment of poliovirus was completed with the development of the draft *WHO Global Action Plan to minimize poliovirus facility associated risk in the post-eradication/post-OPV era (GAP III)*. The development of *GAP III* provides the Global Polio Eradication Initiative with a long-term vision and rational plan to ensure that polioviruses are not reintroduced to human populations once circulation has been interrupted.

GAP III provides the Global Polio Eradication Initiative with a long-term vision and rational plan to ensure that polioviruses are not reintroduced to human populations once circulation has been interrupted.

A key recommendation of *GAP III* is to reduce to fewer than 20 the number of research or production facilities retaining polioviruses worldwide that serve essential functions and meet defined primary and secondary safeguards against transmission. *GAP III* outlines a two-pronged strategy of risk elimination and risk management implemented in four phases, each linked to achievement of milestones in global polio eradication. The first three phases of the plan focus on eliminating and managing the risk of wild polioviruses in facilities after eradication is achieved.

In countries retaining wild poliovirus materials, primary and secondary safeguards are described based on findings from risk assessment and risk consequence models. Primary safeguards were developed in consultation with the WHO department responsible for bio-containment of smallpox along with experts in biosafety and risk management. The resulting *Biorisk management standard (BSL 3/polio) for essential poliovirus facilities in the post-eradication/post-OPV era* establishes a new international benchmark for managing the risk of an eradicated pathogen. This document outlines goals to be achieved by each facility in 16 broad areas based on the principles of a quality management system. It places the responsibility of risk management squarely on the facility and its management and requires that appropriate controls and systems for managing the risk be not only developed but demonstrated during periodic national and international accreditation procedures.

Beyond these primary safeguards, secondary safeguards are necessary in order to minimize the consequences in the unlikely event of a poliovirus release. These include the location of essential poliovirus facilities in areas with high routine national population coverage with IPV (more than 90%) and high quality closed sewage systems with secondary or greater effluent **treatment**.

SABIN IPV

A critical element of risk-reduction in the post-eradication era is the effort to replace wild poliovirus in vaccines with Sabin virus, which is less neuro-virulent and therefore safer. A vaccine manufacturer has been contracted to establish the feasibility of inactivated vaccine production from Sabin strains. Once this "proof-of-principle" is established through the production of what is known as a pharmaceutical batch, the Global Polio Eradication Initiative will sponsor the clinical development of Sabin IPV. In addition, work has begun to establish standards for Sabin IPV through the United Kingdom's National Institute for Biological Standardization and Control. The goal of both these lines of work is a potent vaccine based on the least neuro-virulent strain of virus, reducing the potential risks of manufacturing, handling and taking vaccine.

MANAGEMENT OF RESIDUAL RISKS ASSOCIATED WITH OPV CESSATION

While research and policy activities are focused on identifying and reducing the risks associated with OPV cessation, the residual risk must be managed. The scientific guidance for national immunization policies, the preparation for a vaccine stockpile and the development of monovalent oral polio vaccine type 3 (mOPV3) are all integral to both reduction and management of these risks. Ensuring long-term surveillance of polioviruses must be planned for as well.

IPV INTRODUCTION AND FRACTIONAL DOSE STUDIES

Scientific research helps form national policy decisions on maintaining population immunity in a post-eradication world: this is the goal of fractional IPV dose trials in Cuba and Oman and an IPV project in a tropical country.

The various natural disasters in Indonesia and the importation and a large outbreak of poliomyelitis led to substantial delays in the introduction of IPV in the province of Yogyakarta. This project continues to be a high priority for the Global Polio Eradication Initiative and will answer key scientific questions, including whether IPV-induced immunity will prevent the emergence of VDPVs in a tropical setting, which will potentially influence a future recommendation for an IPV-only schedule for tropical developing countries. While environmental surveillance in the context of this project is ongoing, a policy switch from OPV to IPV is expected in 2007.

Above and beyond the various scientific, programmatic and operational issues affecting IPV use in the developing world, the cost of IPV vaccination is a major decision factor (especially when weighted against limited resources and the opportunity costs). For the past year, AMRO, EMRO and WHO HQ have collaborated in promoting research to evaluate fractional doses of IPV administered intra-dermally by needle-free devices. Such an approach could lead to substantial cost-saving for an IPV schedule.

The implementation of a study series to compare the immunogenicity of fractional doses of IPV administered by needle-free device versus full doses of IPV administered by intramuscular injection began in September 2006, with an initial study set in Cuba, while another set in Oman is expected to begin enrolment in early 2007. The data generated by this study series are intended to facilitate the regulatory approval of fractional doses of IPV.

VACCINE STOCKPILE SOPs AND TENDER PROCESS

The Standard Operating Procedures for an mOPV stockpile were drafted and presented to the ACPE in October 2006. This document sets forth the basis for emergency response in the post-eradication world. Furthermore, it outlines the triggering events for such an emergency response as well as a decision-making mechanism in case mOPV has to be released in an emergency situation. This work represents a major step forward for the Global Polio Eradication Initiative in terms of tools and products to manage a post-eradication response to the re-introduction or re-emergence of **poliovirus.**

The Standard Operating Procedures for the vaccine stockpile set forth the concepts for emergency response in the post-eradication world.

In 2006, mOPV1 was licensed by four different producers: GSK (in Indonesia, Belgium and Nigeria), Panacea and Bio Farma (in Indonesia) and Sanofi Pasteur (in Pakistan). GSK also licensed its mOPV3 in Belgium. Several more applications for licensure of mOPV products are pending with national regulatory authorities.

Another significant achievement in the preparedness for emergency response in a post-eradication world was the UNICEF Request for Commercial Indication (RCI). In December 2006, UNICEF issued its RCI to four manufacturers – all of which are WHO pre-qualified for trivalent OPV products – to provide them with basic information on stockpile requirements for suppliers, such as presentation of the vaccine, the number of doses per serotype, storage and security, etc.

Plans to finance the necessary preparations for a post-eradication world were aided by the launching of the innovative financial issuer, the International Finance Facility for Immunization. The Executive Committee of the GAVI Fund in September 2006 approved the use of US$ 191 million from this issue to help build the stockpile of OPV for the post-eradication era.

Circulating wild polioviruses will become one of the four diseases specifically mentioned in – and "notifiable" under – the International Health Regulations 2005.

POLIO SURVEILLANCE UNDER THE INTERNATIONAL HEALTH REGULATIONS (2005)

With the global reduction and eventual interruption of wild poliovirus, and in a post-eradication world, long-term surveillance for polioviruses takes on a new role. Circulating wild polioviruses will become one of the four diseases specifically mentioned in and "notifiable" under the International Health Regulations 2005 (IHR 2005), which come into effect in June 2007. The evolving relationship between IHR and vaccine-preventable disease control and polio eradication activities, especially at regional and country level, is expected to increase in importance as the Initiative approaches the global interruption of wild poliovirus circulation.

Event-based reporting for polio cases will need to be fully incorporated into existing mechanisms for dealing with events of international public health importance, such as the IHR. Integration of polio into the IHR will further help to prevent, protect, and control the international spread of the disease in the event of an outbreak. As the IHR comes into force, countries will be assessing their capacity to identify, verify, and control potential polio outbreaks.

CURBING THE RISK OF INTERNATIONAL SPREAD OF POLIO

The poliovirus has repeatedly shown its ability to travel great distances, causing importations by land, sea or air travel. To minimize the risk and consequences of potential future importations, countries are protecting themselves with immunization measures.

Full vaccination of all travellers from any polio-affected area may be necessary in the near future. The Executive Board of the World Health Assembly, convening in January 2007 in Geneva, Switzerland, called for an appropriate standing recommendation under the International Health Regulations (2005), after their entry into force in June 2007.

Individual countries are already enforcing similar policies at national level. Saudi Arabia, for example, requires all Hajj travellers from Nigeria, India, Pakista and Afghanistan to be immunized against polio.

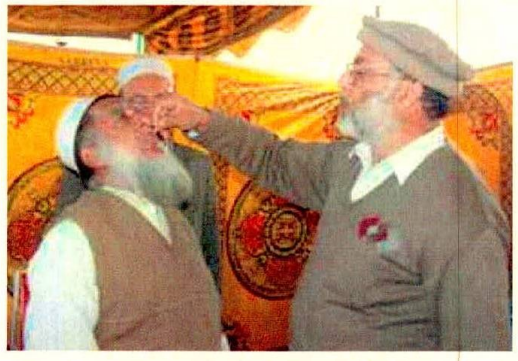


PHOTO © WHO PAKISTAN

Pilgrims from Peshawar, Pakistan, are immunized prior to their departure. Such polio immunization requirements may be instituted by other countries.

3.4 MAINSTREAMING OF THE GLOBAL POLIO ERADICATIONINITIATIVE

Mainstreaming of the Global Polio Eradication Initiative is one of the key strategic objectives. It includes integration of the long-term functions of polio eradication into national and international mechanisms for managing other pathogens and the transition of the polio infrastructure to other programmes such as immunization and outbreak response.

MILESTONES 2006

MILESTONE 1: 75% OF JOINT GAVI/POLIO PRIORITY COUNTRIES IMPLEMENTING INTEGRATED PLANS.

STATUS: **ACHIEVED** — 43/52 (83%) joint GAVI Alliance/Polio priority countries have drafted or finalized comprehensive multi-year plans.

MILESTONE 2: 100% OF COUNTRIES WITH INTEGRATED OR EXPANDED AFP REPORTING, AS APPROPRIATE (ESPECIALLY FOR MEASLES AND NEONATAL TETANUS):

STATUS: **PARTIALLY ACHIEVED.**

- 118/180 (66%) countries with AFP case-based reporting also have measles case-based reporting;
- 180/193 countries have AFP case-based reporting systems.

MILESTONE 3: 75% OF COUNTRIES WILL HAVE GAVI-SUPPORTED ICC AND IF APPROPRIATE, TAG.

STATUS: **ACHIEVED** — 43/52 (83%) of joint GAVI Alliance/Polio priority countries have GAVI Alliance-supported Interagency Coordinating Committees (ICCs) which work on broader issues as demonstrated by their development, approval, dissemination and implementation of comprehensive multi-year plans. Joint GAVI Alliance/Polio priority countries are defined as all GAVI Alliance-eligible countries in polio endemic regions (i.e. AFRO, EMRO, SEARO).

MILESTONE 4: 75% OF POLIO-FUNDED 'HUMAN RESOURCES' FORMALLY CONTRIBUTING TO MULTI-DISEASE PROGRAMMES.

STATUS: **ACHIEVED.**

100% of polio-funded staff contributes formally to multi-disease programmes.

MILESTONE 5: 100% OF COUNTRIES WITH POLIO OPERATIONS ARE FULLY INTEGRATED WITH THOSE FOR MEASLES.

STATUS: **ACHIEVED.**

85% of the institutions performing polio laboratory surveillance are also involved in national measles laboratory surveillance.

INTEGRATION OF LONG-TERM FUNCTIONS

Once wild poliovirus transmission is interrupted, all other poliovirus must be contained, surveillance for them sustained and a stockpile of vaccine maintained. These long-term functions of polio eradication will be integrated with existing mechanisms to help countries prepare for, monitor and respond to public health emergencies and outbreaks.

The International Health Regulations 2005 (IHR – which come into force in June 2007) call on signatories to develop, strengthen and maintain surveillance and response capacities for public health emergencies which may have an international impact. Polio eradication functions which are being incorporated into existing mechanisms to help countries comply with this instrument of international law include: surveillance – in the form of the AFP surveillance and laboratory network; vaccine stockpile and response functions to help deal with disease outbreaks; and laboratory containment functions such as those necessary for smallpox.

INTEGRATION OF CAPACITY AND EXPERIENCE

The global polio infrastructure encompasses its human resources, standards and operational guidelines governing polio eradication activities and the physical assets of the programme such as cars, computers and laboratory equipment. These have each over the years become an integral component of national and regional health systems. An indicator in WHO's *Medium Term Strategic Plan 2008-2013* is the number of countries in which the polio surveillance infrastructure contributes to national core capacity building for IHR.

Countries with implementation of 'RED' activities in 2002–2006

Some 3,300 AFP surveillance and response staff operate in 54 countries, along with thousands more polio communication and social mobilization workers. A survey of 1,500 Global Polio Eradication Initiative-funded staff indicated that 85% give an average of half their time to work that is related to immunization, surveillance and outbreak response for other diseases – constituting the single largest source of such technical assistance to low-income countries. Polio staff helped to support measles mortality reduction activities that have averted 2.3 million deaths between 1999 and 2005[1], bringing the world closer to Millennium Development Goal 4; the human and physical infrastructure of polio eradication is fully involved in routine immunization coverage, the introduction of new and under-used vaccines, the distribution of insecticide-treated bed nets against malaria and the response to health emergencies following earthquakes and other disasters. The "Reach Every District" (RED) strategy that aims to improve access to routine immunization is built on the polio model and is operational in 53 countries. The global polio laboratory network serves to identify and track other diseases, including measles and yellow fever.

Over 85% of polio staff spend an average of half their time on other diseases of public health importance.

As AFP surveillance officers are highly trained and on the ground, they are often the first to respond to haemorrhagic fever outbreaks like Marburg and Ebola, avian influenza, cholera and other serious infectious disease outbreaks for which the WHO's Global Outbreak Alert and Response Network (GOARN) was set up. As the Global Polio Eradication Initiative moves towards interruption of wild poliovirus, GOARN is expected to assume a greater role in polio surveillance.

[1] Wolfson LJ, Strebel P, Gacic-Dobo M, Hoekstra E, McFarland JW, Hersh B, for the Measles Initiative. *Has the 2005 measles mortality reduction goal been achieved? A natural history modelling study.* Lancet 2007; 369: 191-200.

FINANCING

The international community has over the past 19 years invested US$ 5.3 billion in polio eradication, US$ 695 million of this in 2006, a year in which the international donor community continued to make strong promises of financial support. In a statement to the 59th World Health Assembly in May 2006, EU member states re-affirmed their "full support" for polio eradication. G8 leaders, meeting in July 2006 at the G8 Summit in St Petersburg, pledged to continue support to polio eradication, following their 2005 commitment at Gleneagles to "continue or increase" their contributions to consign polio to the history books.

A broad public-private partnership that includes 44 donors of more than US$ 1 million and 27 donors of more than US$ 5 million, the Global Polio Eradication Initiative is, at the end of 2006, in its most precarious financial position ever. Unless additional funds are contributed quickly, the global programme will start to run out of money by mid-2007 and activities will have to be curtailed, putting at risk the 19-year eradication effort. The 2007-2008 global funding gap as of May 2007 stands at US$ 540 million.

The Global Polio Eradication Initiative is, at the end of 2006, in its most precarious financial position ever.

In 2006, governments of polio-affected countries, including Bangladesh, India, Indonesia, Namibia, Nigeria and Pakistan provided domestic funding at unprecedented levels.

The international donor community is urged to translate its public statements of support into funding for countries to finish the job. The humanitarian and economic case for finishing eradication is sound. A new study from Harvard University demonstrates that over a 20 year period, controlling polio at high levels would cost more, in human suffering and dollars, than finishing eradication.

The world has an opportunity to come together to finish polio eradication once and for all and give a perpetual gift to children across the world. The alternative is unacceptable: hundreds of thousands of children would again be paralysed by this disease over the coming years, and billions of dollars would be spent on outbreak response activities, rehabilitation/treatment costs and associated loss of economic productivity. The international community has very few opportunities to do something that is unquestionably good for every child and every country in the world. We owe it to all future generations to succeed.

AUSTRIA

Austria continued its support to polio eradication by committing US$ 710,000 in 2006 for Ethiopia's polio eradication efforts, bringing its total contributions to US$ 1.67 million.

AUSTRALIA

In 2006 Australia provided US$ 804,000 – vaccine funding for polio outbreak response in Nepal, as well as global funding – bringing its total contributions to US$ 16.3 million.

BILL AND MELINDA GATES FOUNDATION

The Bill and Melinda Gates Foundation provided US$ 39.8 million for Nigeria and surrounding countries, with the objective of minimizing spread of poliovirus along the Hajj pilgrimage route. This latest funding brings the Foundation's total commitments to US$ 149.80 million.

CANADA

Taking steps towards fulfilling its G8 promise to "continue or increase" polio funding for 2006–08, Canada in 2006 provided US$ 39 million in global funding, and earmarked an additional US$ 4 million for 2006–07 activities in Afghanistan. These latest contributions bring Canada's total commitments to US$ 181 million.

US CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

In addition to its role as a core technical spearheading partner, CDC provided funding for OPV, operational costs and programme support to UNICEF and WHO. It also continued to support the Investment Partnership for Polio, which sees CDC providing funding to allow countries to buy down to zero World Bank loans for OPV, in effect turning the loans into grants. US Congress in its fiscal year 2006 allocated US$ 101.25 million to CDC for polio eradication. CDC continued to support the international assignment of epidemiologists, virologists and technical officers to assist WHO, UNICEF and polio-endemic countries in implementing polio eradication activities.

CENTRAL EMERGENCY RESPONSE FUND (CERF)

The CERF provided US$ 830,000 to help Somalia and the Democratic Republic of the Congo respond to polio outbreaks.

DENMARK

Denmark contributed US$ 500,000 in 2006 to support Niger's polio eradication programme.

EUROPEAN COMMISSION (EC)

The EC in 2006 continued its support to the polio eradication efforts of 14 African countries and provided US$ 7 million in new funding for Niger. The European Community Humanitarian Office (ECHO) supported the Democratic Republic of the Congo's (DRC's) polio outbreak response with US$ 480,000.

FRANCE

France, which joined the Global Polio Eradication Initiative in 2004, provided US$ 12.6 million in global funding in 2006, as it paid its final instalment on its three-year, US$ 36 million pledge. It also provided technical staff to assist Chad and Niger in their polio eradication programmes.

GLOBAL ALLIANCE FOR VACCINES AND IMMUNIZATION ALLIANCE (GAVI ALLIANCE) AND THE INTERNATIONAL FINANCE FACILITY FOR IMMUNIZATION (IFFIm)

The Executive Committee of the GAVI Fund at its September 2006 meeting approved US$ 191.28 million for the creation, procurement and evaluation of a polio vaccine stockpile as an investment case under the International Finance Facility for Immunisation (IFFIm). This investment will provide the up-front financing needed to establish a mOPV stockpile that GAVI Alliance-eligible countries can access (as needed) in the post-eradication era.

GERMANY

Germany committed an additional US$ 37.2 million in multi-year OPV funding for India's polio eradication effort and signed a new US$ 1.3 million global agreement for 2007–08. These latest contributions bring Germany's total contributions to US$ 142 **million.**

ICELAND

Iceland followed its first-ever contribution to global polio eradication activities in 2005 with a second contribution of US$ 50,000 in 2006.

IRELAND

Ireland signed a 2006–08 global pledge of US$ 10.4 million, double its 2003–05 contribution to polio eradication, and bringing its total polio funding to US$ 16.6 million.

JAPAN

Japan provided US$ 13.4 million for OPV for SIAs in priority countries. Eighty per cent of this funding was earmarked for Pakistan, India, Ethiopia and Nigeria. Japan's 2006 contributions bring its total polio commitments to US$ 312 million.

LUXEMBOURG

Luxembourg pledged US$ 2.76 million for 2006–08, bringing its total polio contributions to US$ 9.08 million. Luxembourg is the highest per capita government donor to the Global Polio Eradication Initiative, having provided US$ 19.14 for every man, woman and child in Luxembourg.

MONACO

Monaco continued its support for polio eradication by providing US$ 78,000 for polio eradication activities in Niger.

NETHERLANDS

The Netherlands Ministry of Health committed US$ 210,000 to support polio work at the Dutch National Institute of Public Health.

NEW ZEALAND

New Zealand contributed US$ 300,000 for global polio eradication efforts through their partnership with local Rotary clubs in the country.

NORWAY

Norway signed a two-year pledge to provide US$ 15.2 million in global funding for 2006–07, bringing its total polio contribution to US$ 50 million.

SULTANATE OF OMAN

The Sultanate of Oman continued its support for global polio eradication efforts by contributing US$ 100,000 in 2006, bringing its total contribution to US$ 200,000.

ROTARY INTERNATIONAL

Rotary International, a spearheading partner of the Global Polio Eradication Initiative, is the largest private sector donor to the Global Polio Eradication Initiative, and the second-largest contributor, after the Government of the United States. In 2006, Rotary International contributed US$ 22.6 million to support polio eradication efforts in priority countries, bringing its total contributions to more than US$ 616 million.

RUSSIAN FEDERATION

The Russian Federation, during its Presidency of the G8 in 2006, kept polio eradication on the G8 agenda during the Summit at St Petersburg and pledged US$ 10 million in global funding for 2006–08, a 25% increase over its 2003–05 **funding.**

SPAIN

In 2006, Spain, through its Agencia Española de Cooperación Internacional, continued its strong support by providing US$ 1.25 million for global polio eradication activities, including funding to maintain and improve certification standard surveillance in Cape Verde, Guinea Bissau, Angola and Namibia.

TRIBUTE TO KOFI ANNAN

The former United Nations Secretary-General Kofi Annan played a critical leadership role in the strong progress made in global polio eradication efforts over the past 10 years. When he assumed his office in 1997, polio was endemic in most of Africa, South-East Asia and the Eastern Mediterranean; even Europe had not been certified polio-free. By the end of his tenure in 2006, only four countries in the world reported indigenous wild poliovirus transmission, and only one of these – Nigeria – is in Africa.

The former Secretary-General personally raised the polio eradication in bilateral meetings with Heads of State of key polio-affected and donor countries and regularly included the subject in his speeches at major events. In 2006, Mr. Annan took some extraordinary actions to advocate with leaders of polio-endemic countries, writing to the Heads of State to express his concern and that of the international community at the increase in the number of reported polio cases. His message of alarm caught the attention of the Heads of State and helped mobilize efforts to improve the quality of polio immunization activities.

Noting that the program faced a critical funding gap for implementing activities in 2006, the Secretary-General also took the initiative to write to the Kings and Heads of Government of the Gulf Cooperation Council member states requesting that they partner in this global effort and provide financial resources. Contributions and pledges are now being received in response to his request. Mr. Annan also contacted the leaders of a number of G8 countries, urging them to fulfil their funding commitments for polio eradication.

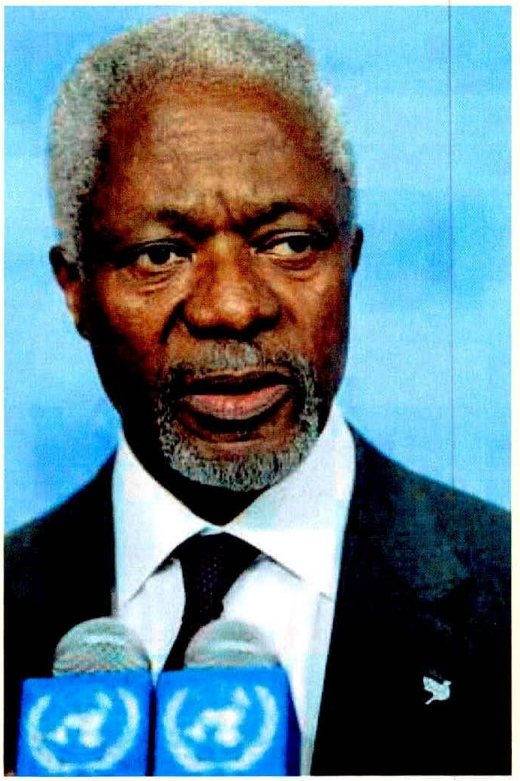


PHOTO © UN PHOTO/P. FILGUEIRAS

UNITED NATIONS CHILDREN'S FUND (UNICEF)

In 2006, spearheading partner UNICEF provided funding for polio eradication activities through several channels:

Regular Resources: UNICEF allocated regular resources of US$ 12 million for polio activities in Afghanistan, Pakistan, India, Nigeria, Angola, Namibia and Sudan.

National Committees: UNICEF National Committees in Switzerland, Iceland, Australia, Canada and the UK together contributed US$ 954,000 for polio eradication activities in priority countries.

UNICEF Country Offices: UNICEF offices in Angola, Bangladesh, DRC, India and Namibia locally reprogrammed US$ 1.7 million in funding for polio eradication activities.

UNITED KINGDOM'S DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID)

DFID's US$ 53.65 million in global and country-specific funding in 2006 brought its total polio contributions to more than US$ 600 million. DFID complemented its flexible global funding with support for Pakistan, India, Somalia, Indonesia and Myanmar, as it continued to take action on the pledge of G8 leaders at the 2005 G8 Summit at Gleneagles to "continue or increase" funding for 2006–08.

UNITED NATIONS FOUNDATION (UNF)

In 2006, the UNF provided US$ 3.34 million for surveillance in WHO's AFRO and EMRO regions, for OPV for Myanmar and operations costs for Nigeria, while also continuing its support to the Global Polio Eradication Initiative's resource mobilization efforts.

USAID

US Congress in its fiscal year 2006 allocated US$ 32 million through USAID to support global polio eradication efforts. In addition, USAID's Office of US Foreign Disaster Assistance (OFDA) provided US$ 200,000 for polio eradication activities in south/central Somalia. USAID's total contributions to polio eradication are more than US$ 322 million.

WORLD BANK

The World Bank provided a US$ 6 million grant to Afghanistan for the purchase of OPV in 2006–07. Nigeria and Pakistan continued to benefit from the World Bank Investment Partnership for Polio, which sees the Bill and Melinda Gates Foundation, Rotary International, CDC and UNF providing funding to allow countries to buy down to zero World Bank loans for OPV, in effect turning the loans into grants. This innovative financing mechanism has since 2003 facilitated the purchase of US$ 165.5 million of OPV in Nigeria and Pakistan.

GLOSSARY OF TERMS

ACPE	Advisory Committee on Poliomyelitis Eradication
AFP	Acute flaccid paralysis
AFRO	WHO Regional Office for Africa
AMRO	WHO Regional Office for the Americas
CDC	US Centers for Disease Control and Prevention
cVDPV	Circulating vaccine-derived poliovirus
DFID	Department for International Development
EC	European Commission
EMRO	WHO Regional Office for the Eastern Mediterranean
EURO	WHO Regional Office for Europe
EPI	Expanded Programme on Immunization
GAP III	WHO Global Action Plan to minimize poliovirus facility associated risk in the post-eradication/post-OPV era
GAVI Alliance	Global Alliance for Vaccines and Immunization
GCC	Global Commission for the Certification of the Eradication of Poliomyelitis
ICC	Interagency Coordinating Committee
IFFim	International Financing Facility for Immunization
IPV	Inactivated polio vaccine
ITN	Insecticide treated net
mOPV	Monovalent oral polio vaccine
NCC	National Certification Committee
NID	National Immunization Days
OIC	Organization of the Islamic Conference
OPV	Oral polio vaccine
RCC	Regional Certification Commission
RED	Reaching Every District
SEARO	WHO Regional Office for South-East Asia
SIA	Supplementary immunization activity
SNID	Sub-national Immunization Days
tOPV	Trivalent oral polio vaccine
UN	United Nations
UNF	United Nations Foundation
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VAPP	Vaccine-associated paralytic polio
VDPV	Vaccine-derived poliovirus
WHA	World Health Assembly
WHO	World Health Organization
WPRO	WHO Regional Office for the Western Pacific

The World Health Organization

The Case for Completing Polio Eradication

'As an international community, we have few opportunities to do something that is unquestionably good for every country and every child, in perpetuity.'

Dr Margaret Chan
Director-General
World Health Organization

The Issue

Without an urgent infusion of international funds, the opportunity to complete polio eradication could be lost forever...

By July 2007 the Global Polio Eradication Initiative (GPEI) will have a negative cash flow, which if not addressed will require an immediate reduction in planned polio eradication activities in the remaining infected countries[1]. Even a temporary cutback would result in the reinfection of polio-free areas, delays in outbreak response, a surge in polio-paralyzed children and an increase in overall costs. Insufficient funds at this late stage imperil the entire 20-year eradication effort, as well as related gains in routine childhood immunization, global communicable disease control, preparedness and response, and other child survival and international health **activities.**

The following 'case statement' was developed following an 'Urgent Stakeholder Consultation on Polio Eradication' convened by the Director-General of the World Health Organization (WHO) on 28 February 2007 at the WHO Headquarters in Geneva, Switzerland. The list of participants, agenda, presentations and other related materials from the Consultation are available at www.polioeradication.org.

---

[1] At 10 May 2007, 4 countries had yet to stop indigenous poliovirus (i.e. 'endemic' countries: Afghanistan, India, Nigeria, Pakistan); 6 of the 26 countries reinfected since 2003 by virus that originated in an endemic country had not yet stopped transmission again (i.e. Angola, Bangladesh, Democratic Republic of the Congo, Ethiopia, Myanmar, Somalia); 4 additional countries that border 'endemic' areas continue to suffer sporadic importations (i.e. Cameroun, Chad, Nepal, Niger).

The Context

In 1988, over 350 000 children were being paralyzed by polio every year...

Despite the availability of an effective, cheap, oral polio vaccine (OPV) for more than 25 years, over 350 000 children in at least 125 countries were still being permanently paralyzed by wild polioviruses[2] each year when the Global Polio Eradication Initiative (GPEI) was launched in 1988.

By 1999, the GPEI had reduced annual polio cases by 99% and proven the feasibility of eradication...

The technical feasibility of eradicating wild-type poliovirus was confirmed in October 1999 when the last case of paralytic polio due to wild poliovirus type 2 (1 of 3 types) was detected anywhere in the world. By 2002, the feasibility of eradication was reaffirmed by certification of eradication of all 3 wild poliovirus types in 3 of the 6 WHO **Regions.**

In 2003, limited cutbacks in eradication activities led to a huge resurgence of polio...

In mid-2003 two northern Nigeria states that were heavily infected with polio unexpectedly suspended OPV use (stating it might be 'contaminated'), leading to a national epidemic[3]. This occurred shortly after the GPEI shifted tactics, in part due to limited financing, stopping campaigns in most polio-free areas of Africa, Asia and the Middle East to focus resources on endemic countries. Since 2003, 20 polio-free countries in these areas have suffered new outbreaks following importations of a poliovirus from Nigeria while virus originating in India re-infected another 6 countries. In total, thousands of children in polio-free areas were paralyzed, requiring the additional expenditure of over US$ 450 million for emergency response activities.

In 2006, 4 countries still had indigenous poliovirus, prompting some to propose that eradication be abandoned...

Citing the high costs of completing polio eradication relative to the low number of remaining cases, and suggesting the last 4 endemic countries and some re-infected countries could not fully implement the strategies, some public health officials proposed the eradication goal be abandoned for one of 'effective control'. This proposal was made amid increasing international awareness and discussion of other risks, such as the fatigue of health workers and volunteers after years of campaigns, historical gaps in surveillance quality and competing development priorities.

---

[2] 'Wild' denotes naturally occurring polioviruses which circulate(d) among humans. 'Sabin-strain' denotes the attenuated polioviruses that are used to make oral poliovirus vaccine (OPV).

[3] Centers for Disease Control and Prevention. Resurgence of wild poliovirus type 1 transmission and consequences of importation into 21 previously polio-free countries, 2002-2005. *Morbidity and Mortality Weekly Report* 2006; 55: 145-50.

The Case for Completing Polio Eradication

A new study shows switching to polio 'control' would actually cost more than completing eradication...

Advocates of 'effective control' (which they define as maintaining <500 polio cases/year indefinitely) predicted this could be achieved at lower costs than completing eradication[4]. However, an independent analysis found that 'effective control' would actually result in a much higher burden of disease and at costs that would exceed, by billions of dollars over a 20-year period, those of completing eradication[5].

New analyses confirm that returning to routine immunization alone for polio control would result in over 200 000 children again paralyzed by polio each year...

The international spread of polio from Nigeria in 2003 showed that the number of cases could increase very rapidly if eradication were not completed[3]. New mathematical models found that regardless of the control strategy, in low-income countries alone a switch to 'control' would result in up to 4 million polio-paralyzed children over the next 20 years[5]. This increase in polio would disproportionately affect poor populations, with the vast majority of cases occurring in countries with a GDP of < US$ 1000/year.

New tools greatly enhance the impact of the eradication strategies[6]*...*

A recent study confirms that new polio vaccines ('monovalent OPVs' or 'mOPVs'), developed by an extraordinary public-private partnership in 2005-6, substantially enhance the impact of polio campaigns[7]. Dose for dose, these vaccines more than double a child's protection against the specific type of polio present in a country, as compared with the traditional trivalent OPV. GPEI is also assessing the potential role of inactivated polio vaccine (IPV) in case polio is found to persist in an area with very high mOPV coverage.

New measures are reducing the risk and consequences of new outbreaks in polio-free areas...

Since the World Health Assembly in 2006 endorsed faster, larger and more sustained polio outbreak responses, only 6% of new cases have been due to importations, compared with 52% in 2005. The speed of outbreak response activities has been

---

[4] Arita I. Public health. Is polio eradication realistic? *Science* 2006; 312(5775): 852-4.

[5] Thompson KM, Tebbens RJ. Eradication versus control for poliomyelitis: an economic analysis. *Lancet.* 2007; 369(9570): 1363-71.

[6] GPEI's 4-pronged strategy (routine immunization, National Polio Immunization Days (NIDs), acute flaccid paralysis (AFP) surveillance, and 'mop-ups') used trivalent oral poliovirus vaccine (tOPV).

[7] Grassly NC. Protective efficacy of a monovalent oral type 1 poliovirus vaccine: a case-control study. *Lancet.* 2007; 369(9570): **1356-62.**

further enhanced by new laboratory methods introduced in late 2006 to reduce by 50% the time needed to confirm polio infections and, since 2005, a doubling of surveillance sensitivity performance targets in all high-risk countries.

New tactics are tailored to address the specific challenges in the last 4 endemic countries...

By late 2006, 'Immunization Plus Days' (IPDs) in Nigeria were combining mOPV with other interventions, substantially increasing routine immunization coverage, community acceptance and political support. In India, a new accelerated mOPV campaign schedule is boosting young child immunity more rapidly than in 2006. In Pakistan and Afghanistan, a new, multi-pronged approach includes cross-border synchronization of campaigns, tracking of nomad populations and negotiating access with local leaders and military forces. In all 4 countries, religious and traditional leaders have substantially increased their role to better engage local communities.

In the last 4 endemic countries, the Head of Government is now directly engaged in completing eradication ...

On 28 February 2007, the Heads of Government of Afghanistan, India, Nigeria and Pakistan sent personal envoys to lead their delegations to the Director-General's *Urgent Stakeholder Consultation on Polio Eradication* at WHO, Geneva. This level of government can marshal cross-ministerial, cross-sectoral support for new tactics to reach every child in each infected area. In 2 of the 4 countries the impact of this support is already evident in new pledges totalling US$ 311 million in domestic financing for polio activities.

Completing eradication will benefit the Millennium Development Goals (MDGs)...

The investment in GPEI pays major dividends beyond preventing 5 million polio cases to date. Over 85% of the fulltime GPEI staff (approximately 3 400 people at 1 May 2007) work on other disease control activities for an average of 50% of their time. This GPEI investment has helped avert 1.25 million deaths through Vitamin A supplementation and 2.3 million deaths through measles mortality reduction activities[8]; boost routine immunization and introduce new vaccines in GAVI-eligible countries; respond to international health emergencies such as SARS and Avian Influenza[9]; and facilitate a rapid response to humanitarian crises such as the South Asia Tsunami in 2004 and the Pakistan earthquake in 2005. Further investing in eradication will facilitate the continued integration of the GPEI's infrastructure and operations with other activities, and prevent the harmful consequences of an inadvertent collapse in GPEI **support.**

---

[8] Wolfson LJ. Measles Initiative. Has the 2005 measles mortality reduction goal been achieved? A natural history modelling study. *Lancet* 2007; 369(9557): 191-200.

[9] Heymann DL, Aylward RB. Poliomyelitis eradication and pandemic influenza. *Lancet* 2006; 367(9521): 1462-4.

Immediate Actions to Intensify Polio Eradication Efforts (within 6 months)

Exploiting the new tools, tactics and commitments to accelerate polio eradication during 2007-8 requires immediate action by all GPEI stakeholders. For endemic countries, the priority is to increase the number of children vaccinated with the new mOPVs in each polio-infected district during each campaign. At the international level, the focus is on ensuring the GPEI has the financing and political support needed to implement polio campaigns and surveillance of the highest possible quality.

National activities (polio-endemic countries)

1. *Polio as a National Priority:* a government mechanism will be established at national and state/province levels to coordinate cross-ministerial and cross-sectoral inputs regularly (at least every 2 months) and report to the head of government. 'Polio officers' will implement the decisions of these bodies, with overall responsibility for performance in their area.

2. *Social Mobilization & Communications:* a national-international review will develop a comprehensive plan of action to engage communities in infected districts, optimize mass media use, increase the role of local influencers and proactively deal with rumours. Standard indicators will be analyzed during each campaign, with a revision of the plan if appropriate.

3. *Campaign Quality & Monitoring:* to reach >95% of children in infected districts, microplans will be redone to international standards with all areas mapped and assigned to vaccinators acceptable to the community; local organizations and NGOs will be engaged, especially religious and women's groups. Independent teams will monitor campaigns in high-risk areas[10] and report to the national polio technical advisory body. In infected districts, areas achieving <90% coverage will be revisited and **revaccinated.**

4. *Routine Immunization:* coverage targets will be established for polio-infected districts and, with key process indicators[11], included in data reviewed during each meeting of national technical advisory body.

5. *Research & Introduction of New Tools:* research to guide activities (e.g. serosurveys, IPV studies, pilots of new interventions) will be identified by technical advisory bodies and addressed within 6 months. New tools will be rapidly introduced (e.g. by licensing at least 2 of each mOPV1 and mOPV3).

6. *Domestic Financing:* 3-year eradication budgets will be established or updated, domestic financing will be finalized, and a high-level national Interagency Coordinating Committee (ICC) meeting will be convened 2 times per year with development partners and the Ministry of Finance to discuss or clarify domestic financing.

---

[10] Highest risk areas for missing children during polio campaigns, as identified by a high burden of disease, a high proportion of 'never vaccinated children', historically poor campaign performance, etc.

[11] Key process indicators may include the proportion of routine immunization positions that are vacant, routine immunization sessions conducted and vaccine stockouts.

International activities (donors and partner agencies)

1. *International Financing:* development partners will include the *'Case for Completing Polio Eradication'* in G8 meetings, meetings of the OECD-DAC, the World Bank Development Committee, the Organization of Islamic Conference (OIC) and Boards of the Global Alliance for Vaccines and Immunization (GAVI).

2. *International Advocacy:* the Director-General of WHO will travel to each of the 4 endemic countries to discuss the intensified eradication effort with the Head of Government. The *'Case for Completing Polio Eradication'* will also be brought to the attention of the political leaders and organizations that support the GPEI, through the summits of the G8, the Organization of Islamic Conference (OIC), the African Union, the South Asian Association for Regional Cooperation (SAARC) and the **Commonwealth**.

3. *Enhancing the Safety of Polio Workers & Volunteers:* WHO, UNICEF and relevant international stakeholders will assist national efforts to advocate for Days of Tranquillity and/or other mechanisms to ensure the safe passage of vaccinators to reach all children in insecure areas and areas of active conflict.

4. *International Coordination of Campaigns:* WHO and UNICEF will assist countries to synchronize campaigns where this is needed to optimize coverage of moving populations (e.g. Afghanistan/Pakistan, India/Nepal, Nigeria/Niger).

5. *Limiting International Spread of Polio:* WHO and UNICEF will assist reinfected countries to implement rapid responses to polio outbreaks. WHO will also assist in updating national immunization policy to reduce the risk of polio importations.

Milestones for an Intensified Polio Eradication Effort

Progress towards the following milestones will demonstrate whether the 'immediate actions for an intensified eradication effort' are being implemented and achieving the expected impact on stopping polio transmission in endemic and reinfected countries.

1. Endemic Countries: Reduction in Polio-Infected Districts

   - by end-2007 there should be a 50% reduction in the number of polio-infected districts relative to 2006.

   - by end-2008 polio transmission should be interrupted *or* there should be at least a further 50% reduction in the number of infected districts relative to 2007.

2. Endemic Countries: Increase in Protection Against Polio in Infected **Districts**[12]

   - by end-2007 the level of immunity against polio among children aged 6-35 months in infected districts should be at least at the level in polio-free districts.

   - by end-2008 the level of polio immunity among children aged 6-35 months in infected districts should have been at least as high as in polio-free districts, for at least 12 months.

3. Reinfected Countries: Rapid Cessation of New Polio Outbreaks

   - by end-2007, countries reinfected in 2006 will have implemented appropriate response activities[13] and interrupted transmission of the imported poliovirus.

   - by end-2008, any country reinfected in 2007 will have implemented response activities and interrupted transmission of the imported poliovirus.

4. International Stakeholders: Closure of the Financing Gap[14]

   - by mid-2007 sufficient funding will have been pledged to finance all eradication activities planned through end-2007.

   - by end-2007 sufficient funding will have been pledged to finance all eradication activities planned through end-2008.

---

[12] Measured by the vaccination status of non-polio acute flaccid paralysis (AFP) cases aged 6-35 months and, if appropriate, adjusted for differences in vaccine efficacy compared with polio-free areas.

[13] World Health Assembly Resolution WHA59.1.

[14] As outlined in the relevant edition of the Financial Resource Requirements of the Global Polio Eradication Initiative (FRRs) at www.polioeradication.org.

Monitoring the Intensified Polio Eradication Effort

Stakeholders can monitor progress towards the milestones and activities of the intensified eradication effort on the GPEI website www.polioeradication.org, and in GPEI publications (e.g. PolioNews and the GPEI Annual Report).

In each endemic country, activities will be monitored and guided every 4-6 months by the polio technical advisory body (the Expert Review Committee (ERC) in Nigeria; the Technical Advisory Group (TAG) in Afghanistan and Pakistan; and the India Expert Advisory Group (IEAG)). At the international level, activities will be monitored by the Advisory Committee on Polio Eradication (ACPE) every 6 months (with a face-to-face meeting every 12 months) and by regional advisory committees each year.

The findings of the technical advisory bodies will be posted on the GPEI website within 10 days of each meeting and will be reflected in the annual reports of the Secretariat to the World Health Assembly. Follow-up stakeholder consultations will be convened every 12 months.

A Call to Action to Finance an Intensified Eradication Effort, 2007-8

Implementing the 'immediate actions' to intensify the GPEI requires a rapid injection of multi-year flexible funding, without which the opportunity to eradicate polio will be lost. As of 10 May 2007, the GPEI had a funding gap of US$ 540 million for 2007-8. Activities and staff will have to be cut back as early as July 2007 if US$ 100 million of the funding gap is not secured by that time. A further US$ 100 million of the funding gap requirement is needed by November 2007.

Summary of external financing required by major category of expenditure, 2007-8 (US$ millions)[15]

Major Expenditures	2007	2008	2007-2008
Oral polio vaccine	$ 227.98	$ 176.09	$ 404.07
Campaign operations	$ 230.69	$ 163.81	$ 394.50
Outbreak response/ mOPV evaluation	$ 50.00	$ 35.00	$ 85.00
Surveillance	$ 61.09	$ 59.47	$ 120.56
Laboratory	$ 8.37	$ 8.45	$ 16.82
Technical assistance	$ 87.90	$ 83.35	$ 171.25
Certification and containment	$ 12.00	$ 12.00	$ 24.00
Products for the post-eradication era	$ 5.00	$ 5.00	$ 10.00
Vaccine for post-eradication stockpile	$ 12.70	$ 31.60	$ 44.30
Subtotal	**$ 695.72**	**$ 574.77**	**$ 1,270.50**
Contributions	$ 493.80	$ 237.73	$ 731.53
Funding gap	**$ 201.92**	**$ 337.04**	**$ 538.97**

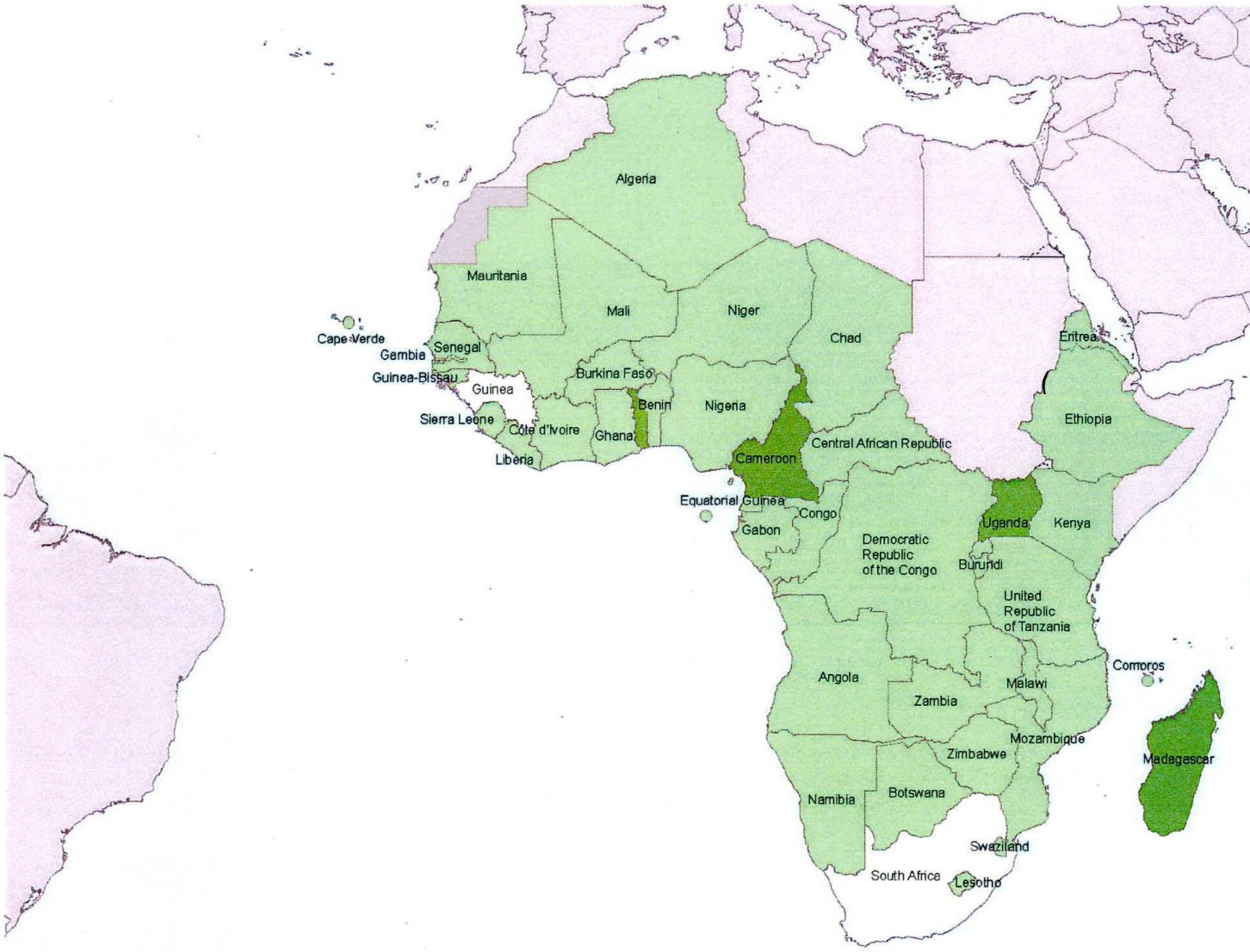
Budget notes:

- conducting additional campaigns to raise immunity in polio-free countries at moderate risk of importations would cost an additional US$ 110 million per year.
- a 12-month delay in completing eradication in the Pakistan/Afghanistan reservoirs, Nigeria or India would increase costs by a minimum of US$ 45 million, US$ 80 million and US$ 140 million, respectively.
- after interrupting wild poliovirus transmission globally, US$ 661 million will be required over the next 3 years for certification and post-eradication preparedness.

[15] Details can be found in the Financial Resource Requirements of the Global Polio Eradication Initiative (FRRs) at www.polioeradication.org .

International Health Regulations (2005)

Designation of National IHR Focal Points in WHO African Region, as of

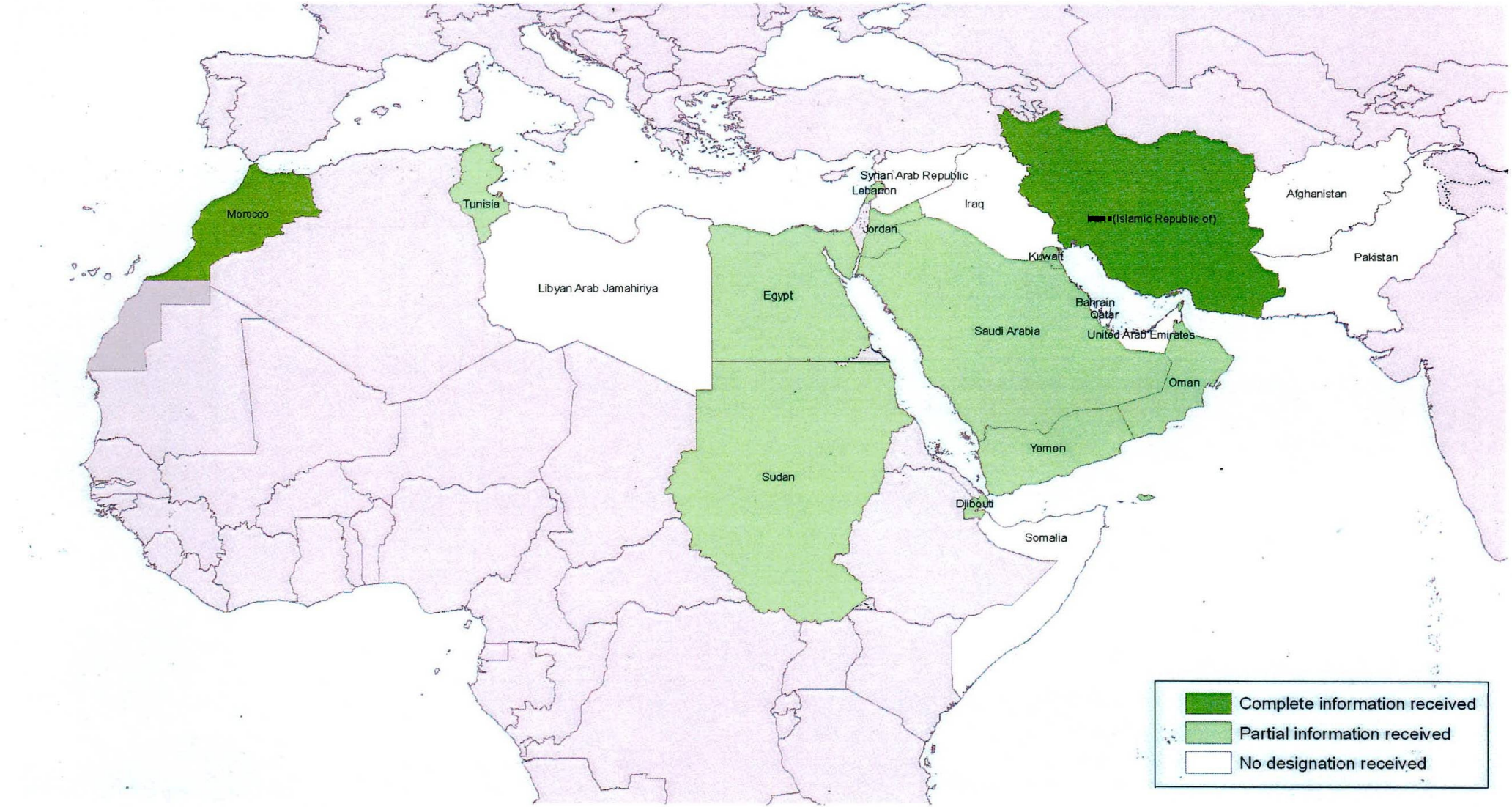


Map production: Public Health Mapping and GIS Unit, International Health Coordination Programme.
Data source: International Health Coordination Programme.
Administrative boundaries source: FAO Global Administrative Unit Layers (GAUL) 2007.

International Health Regulat

International Health Regulations (2005)

Designation of National IHR Focal Points in WHO Eastern Mediterranean Region, as of 7 May 2007



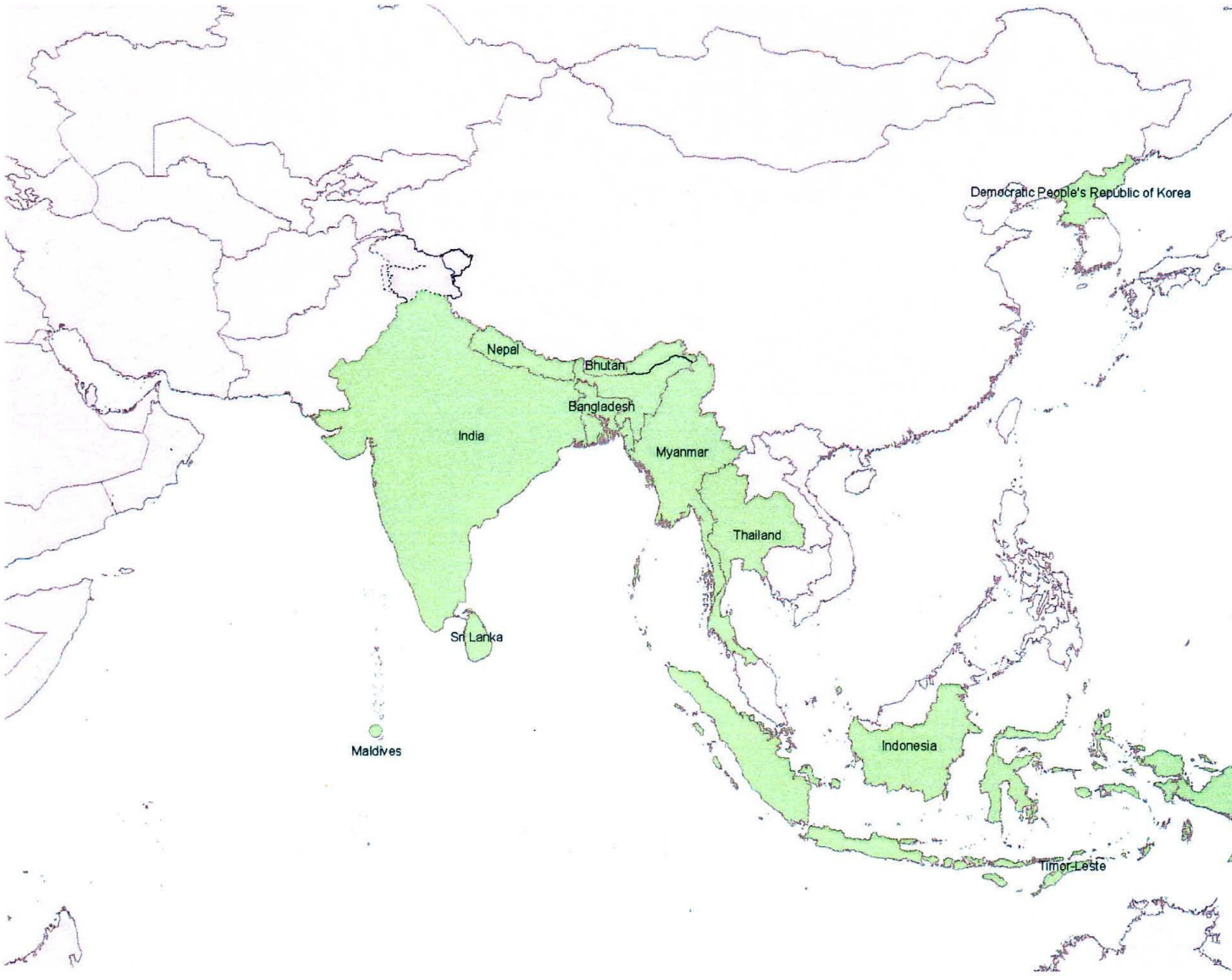
Map production: Public Health Mapping and GIS Unit, International Health Coordination Programme.
Data source: International Health Coordination Programme.
Administrative boundaries source: FAO Global Administrative Unit Layers (GAUL) 2007.

International Health Regulations Coordination Programme

World Health Organization

International Health Regulations (2005)

Designation of National IHR Focal Points in WHO South-East Asia Region, as

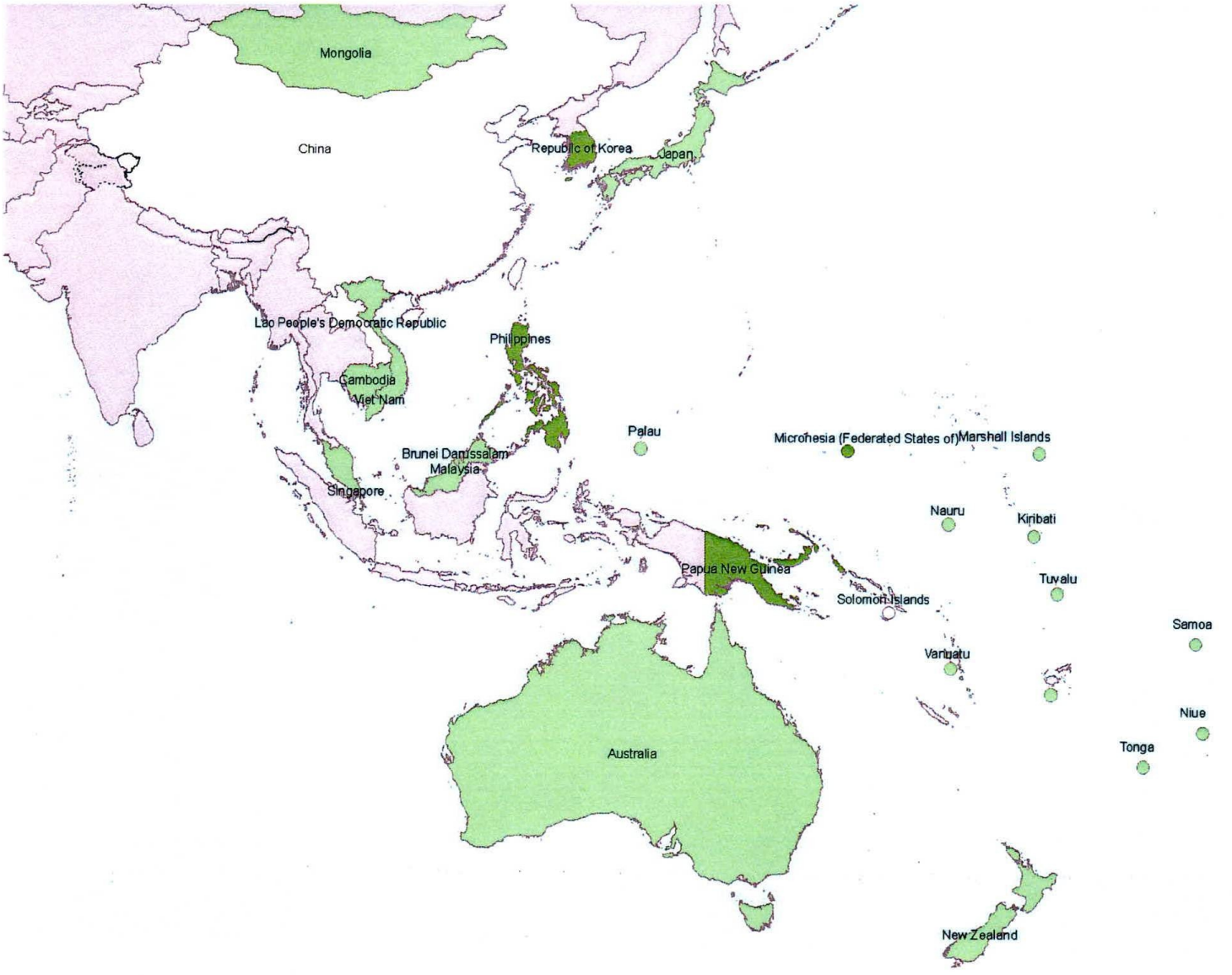


Map production: Public Health Mapping and GIS Unit, International Health Coordination Programme.
Data source: International Health Coordination Programme.
Administrative boundaries source: FAO Global Administrative Unit Layers (GAUL) 2007.

International Health Regulati

International Health Regulations (2005)

Designation of National IHR Focal Points in WHO Western Pacific Region, as

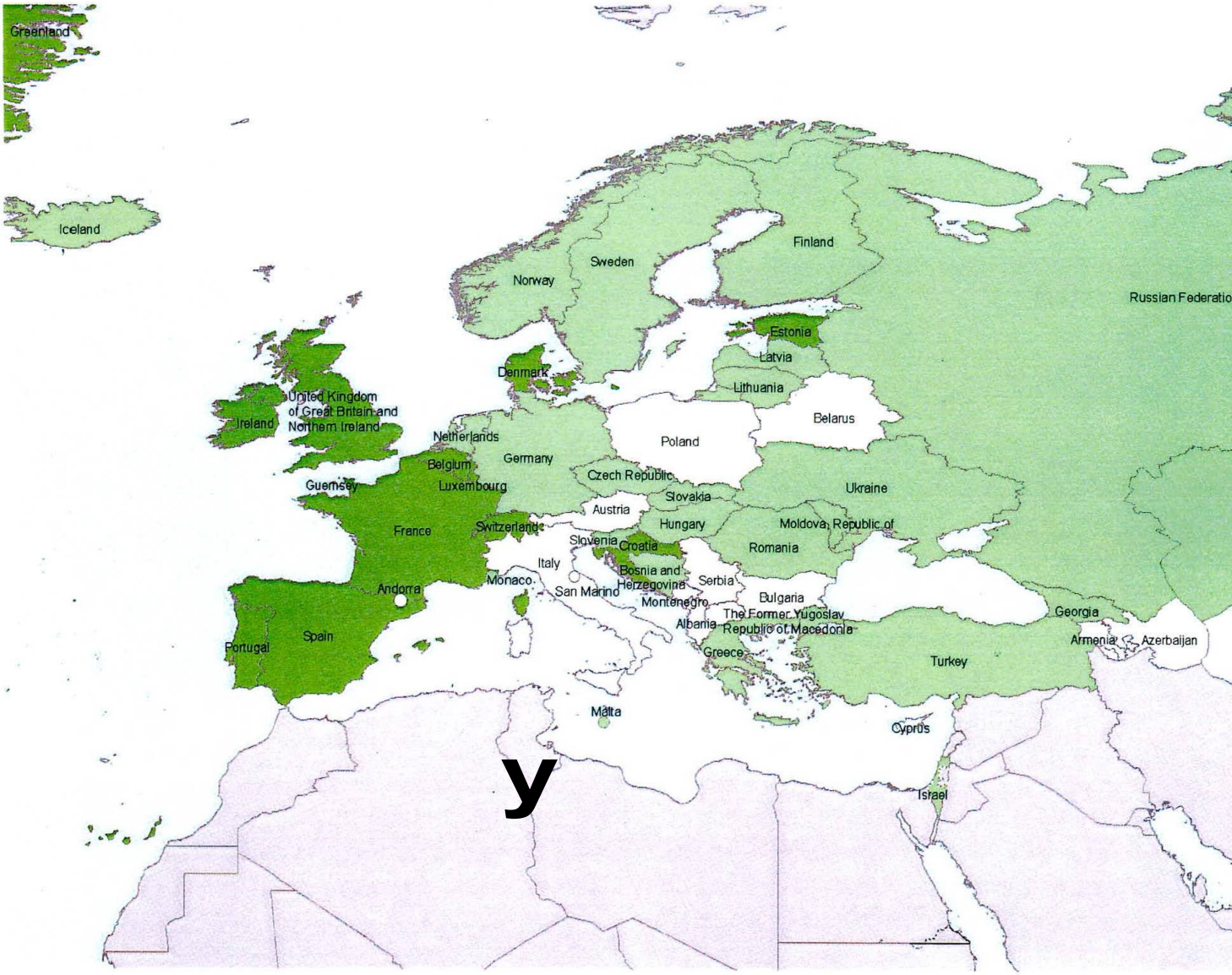


Map production: Public Health Mapping and GIS Unit, International Health Coordination Programme.
Data source: International Health Coordination Programme.
Administrative boundaries source: FAO Global Administrative Unit Layers (GAUL) 2007.

International Health Regulati

International Health Regulations (2005)

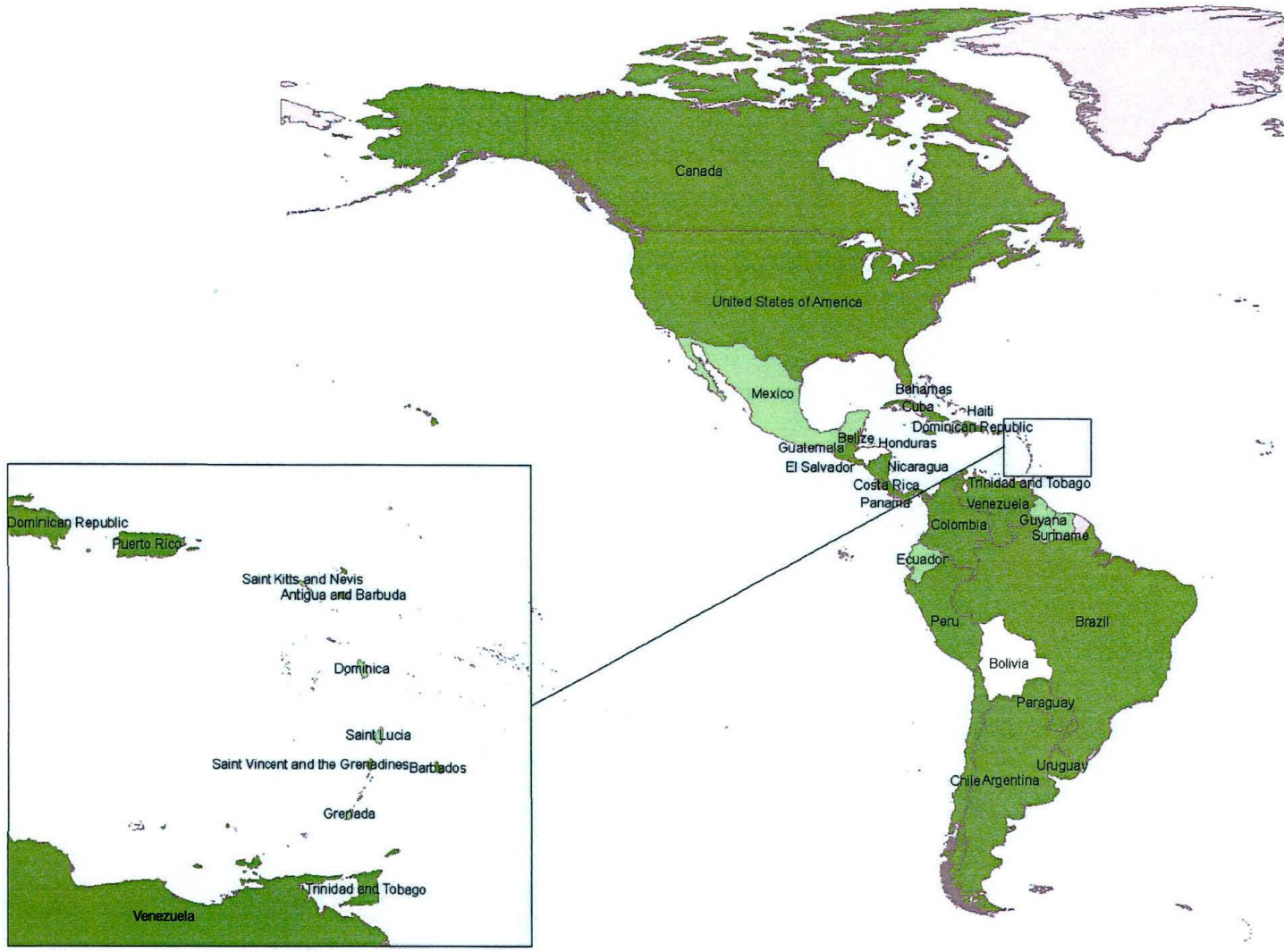
Designation of National IHR Focal Points in WHO European Region, as o



Map production: Public Health Mapping and GIS Unit, International Health Coordination Programme.
Data source: International Health Coordination Programme.
Administrative boundaries source: FAO Global Administrative Unit Layers (GAUL) 2007.

International Health Regulations (2005)

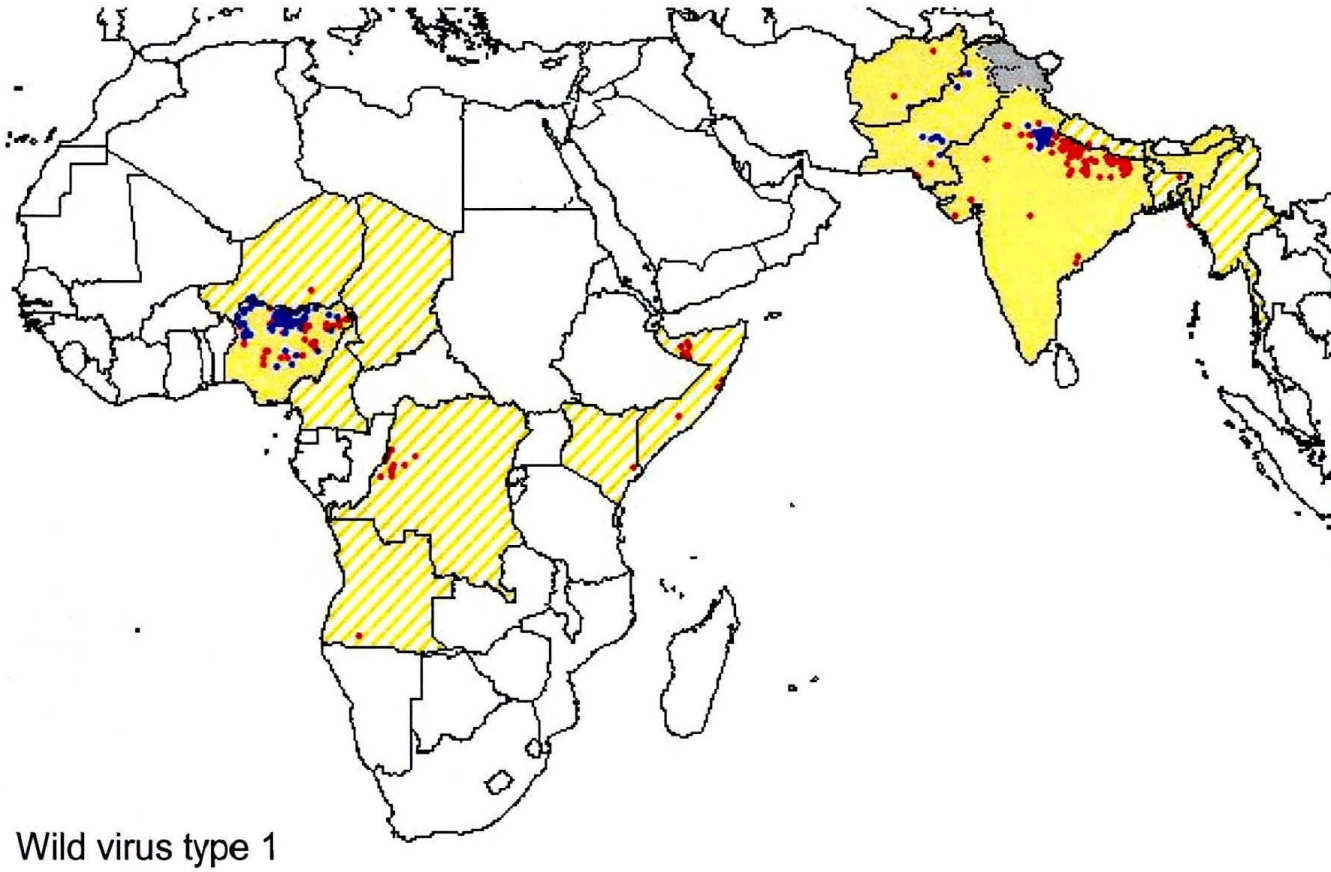
Designation of National IHR Focal Points in WHO Region of the Americas, as of



Map production: Public Health Mapping and GIS Unit, International Health Coordination Programme.
Data source: International Health Coordination Programme.
Administrative boundaries source: FAO Global Administrative Unit Layers (GAUL) 2007.

International Health Regulat

Wild Poliovirus*, 09 Nov 2006 to 08 Ma



- Wild virus type 1
- Wild virus type 3
- Wild virus type 1 & 3

Endemic countries

Case or outbreak following importation (0 - 6 months)

*Excludes viruses detected from environmental surveillance and vaccine derived polio viruses.

Data in WHO HQ as of 08 May 2007

Wild Poliovirus 2000 - 2007

Country or territory	Wild virus confirmed cases													Wild virus
	Total							01 Jan - 08 May[1]		Advance notice	Date of most recent type3	Date of most recent type1	Date of most recent confirmed case	
	2000	2001	2002	2003	2004	2005	2006[3]	2006	2007					2002	2003	20
Afghanistan	27	11	10	8	4	9	31	6	1		17-Oct-06	10-Apr-07	10-Apr-07	2		
Nigeria	28	56	202	355	782	830	1123	245	68		28-Mar-07	29-Mar-07	29-Mar-07			
Pakistan	199	119	90	103	53	28	40	2	7		27-Mar-07	30-Jan-07	27-Mar-07			
Myanmar**	2	0	0	0	0	0	0	0	2		NA	26-Mar-07	26-Mar-07			
India	265	268	1600	225	134	66	674	26	44		09-Mar-07	25-Mar-07	25-Mar-07	73	49	1
Somalia**	46	7	3	0	0	185	36	20	8		06-Oct-02	25-Mar-07	25-Mar-07			
DRC**	28	0	0	0	0	0	13	0	12		07-Sep-00	16-Mar-07	16-Mar-07			
Niger ***	2	6	3	40	25	10	11	3	3		11-Feb-07	05-Mar-07	05-Mar-07			
Nepal**	4	0	0	0	0	4	5	1	0		28-Nov-00	22-Dec-06	22-Dec-06			
Cameroon*	0	0	0	2	13	1	2	0	0		22-Aug-06	06-Dec-06	06-Dec-06			
Chad**	4	0	0	25	24	2	1	0	0		26-Nov-06	07-Dec-05	26-Nov-06			
Bangladesh**	1	0	0	0	0	0	18	1	0	1 (16 Mar)	23-Oct-99	22-Nov-06	22-Nov-06			
Angola**	55	1	0	0	0	10	2	0	0		NA	14-Nov-06	14-Nov-06			
Kenya*	0	0	0	0	0	0	2	0	0		NA	13-Nov-06	13-Nov-06			
Ethiopia**	3	1	0	0	1	22	17	2	0		NA	07-Nov-06	07-Nov-06			
Namibia*	0	0	0	0	0	0	18	0	0		NA	26-Jun-06	26-Jun-06			
Indonesia*	0	0	0	0	0	303	2	2	0		NA	20-Feb-06	20-Feb-06			
Yemen*	0	0	0	0	0	478	1	1	0		NA	02-Feb-06	02-Feb-06			
Sudan**	4	1	0	0	128	27	0	0	0		07-Sep-04	17-Jun-05	17-Jun-05			
Mali*	0	0	0	0	19	3	0	0	0		NA	01-May-05	01-May-05			
Eritrea*	0	0	0	0	0	1	0	0	0		NA	23-Apr-05	23-Apr-05			
Guinea*	0	0	0	0	7	0	0	0	0		NA	06-Dec-04	06-Dec-04			
CAR**	3	0	0	1	30	0	0	0	0		NA	10-Nov-04	10-Nov-04			
Saudi Arabia*	0	0	0	0	1	0	0	0	0		NA	09-Nov-04	09-Nov-04			
Côte d'Ivoire**	1	0	0	1	17	0	0	0	0		16-Feb-99	03-Oct-04	03-Oct-04			
Burkina Faso*	0	0	1	11	9	0	0	0	0		NA	29-Sep-04	29-Sep-04			
Benin**	1	0	0	2	6	0	0	0	0		NA	01-Jun-04	01-Jun-04			
Egypt	4	5	7	1	1	0	0	0	0		07-Dec-00	03-May-04	03-May-04	26	14	1
Botswana*	0	0	0	0	1	0	0	0	0		NA	08-Feb-04	08-Feb-04			
Ghana**	1	0	0	8	0	0	0	0	0		NA	29-Sep-03	29-Sep-03			
Togo*	0	0	0	1	0	0	0	0	0		NA	22-Jul-03	22-Jul-03			
Lebanon*	0	0	0	1	0	0	0	0	0		NA	23-Jan-03	23-Jan-03		1	
Zambia*	0	3	2	0	0	0	0	0	0		NA	27-Feb-02	27-Feb-02			
Algeria*	0	1	0	0	0	0	0	0	0		NA	13-Oct-01	13-Oct-01			
Georgia*	0	1	0	0	0	0	0	0	0		NA	02-Sep-01	02-Sep-01			
Bulgaria*	0	2	0	0	0	0	0	0	0		NA	24-Apr-01	24-Apr-01			
Mauritania[§§]	0	1	0	0	0	0	0	0	0		NA	31-Mar-01	31-Mar-01			
Iran*	3	0	0	0	0	0	0	0	0		NA	18-Dec-00	18-Dec-00			
Cape Verde*	12	0	0	0	0	0	0	0	0		NA	13-Dec-00	13-Dec-00			
Congo	22	0	0	0	0	0	0	0	0		29-Sep-00	28-Nov-00	28-Nov-00			
Iraq	4	0	0	0	0	0	0	0	0		NA	28-Jan-00	28-Jan-00			
Oman	0	0	0	0	0	0	0	0	0		NA	NA	NA			
West Bank & Gaza Strip	0	0	0	0	0	0	0	0	0		NA	NA	NA	2		
Total	**719**	**483**	**1918**	**784**	**1255**	**1979**	**1996**	**309**	**145**	**1**				**103**	**64**	**1**
Tot. in endemic countries	702	475	1915	732	999	943	1868	279	120							
Tot. in non-end countries	17	8	3	52	256	1036	128	30	25							
No. of countries	**23**	**15**	**9**	**15**	**18**	**16**	**17**	**11**	**8**							
No. of endemic countries	**20**	**10**	**7**	**6**	**6**	**6[§]**	**4**									

Countries highlighted in yellow are currently endemic.

Countries highlighted in pale yellow are currently considered to have active transmission of an imported poliovirus.

[1] Data in WHO HQ on 09 May 06 for 2006 data and 08 May 07 for 2007 data

[2] Wild viruses from environmental samples, contacts and other non-AFP sources.

[3] Data for 2006 is not final.

[§] In 2005, no wild viruses occurred in Egypt, but it's status remained endemic.

*All cases are importation related. **All cases from 2003 onward are importation re

***All cases from 2005 onward are importation related. [§§]Wild virus of unknown orig

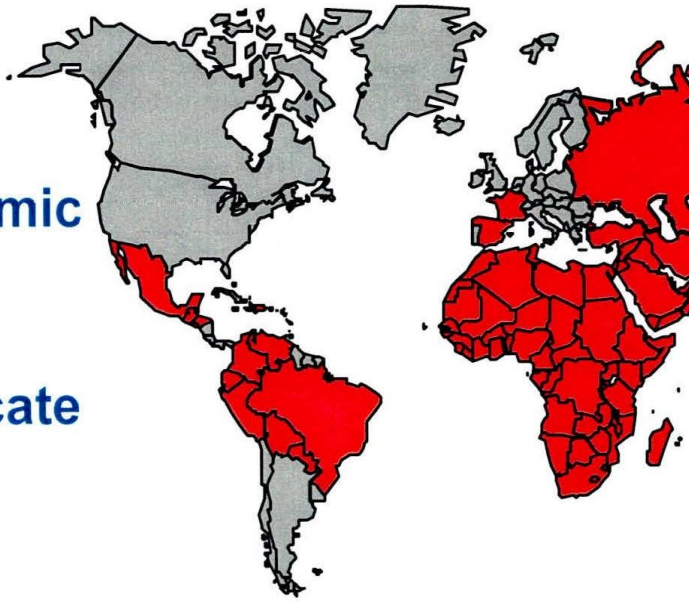
NA. Most recent case had date of onset prior to 1999.

Data in WHO HQ as of 08 May 2007

Progress in eradication polio s

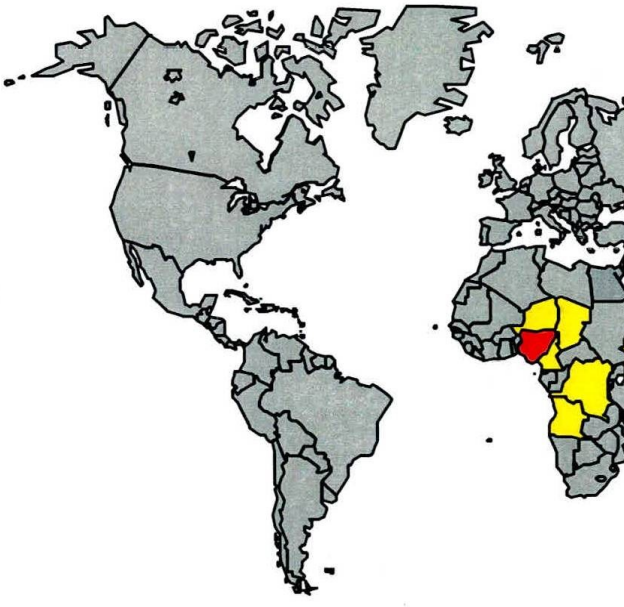
Polio in 1988:

- More than 125 polio-endemic Countries
- More than 350,000 cases
- WHA Resolution to eradicate polio



Polio in 2007:

- 99% reduction since 1988
- 145 cases (as at 8 May 2007)
- Lowest number of endemic countries ever



Polio-endemic country

Outbreak following re-infection (since Nov 2006)

NOW, MORE THAN EVER: STOP POLIO FOREVER.

World Health Organization · CDC · unicef

Partners in the Global Polio Eradication Initiative

Monthly Situation Report

All data as of 8 May 2007

For detailed news and latest polio case data by country, updated every week: www.polioeradication.org

Headlines

- **WHO DG meets Afghanistan and Pakistan heads of state on polio :** On 29 April and 1 May, WHO Director-General Dr Margaret Chan and EMRO Regional Director Dr Hussein A Gezairy met with President Hamid Karzai of Afghanistan, and Prime Minister Shaukat Aziz of Pakistan. Discussions focused on both countries' combined efforts to interrupt the final chains of polio transmission which straddle their common border. In particular, the leaders discussed new approaches to increasing access to all populations, including the use of Days of Tranquility in Afghanistan, engaging semi-autonomous populations in Pakistan and reaching mobile populations travelling across the common border. In Afghanistan, Dr Chan also met with NATO and the International Security Assistance Force to explore ways of negotiating pauses in conflict to allow polio vaccination teams safe passage during campaigns. For further information, please click here.
- **Lancet studies show cost-effectiveness of polio eradication and efficacy of monovalent OPV type 1:** *The Lancet* published two studies with important implications for the Global Polio Eradication Initiative. The first study, by Kim Thompson et al from Harvard University, demonstrates the cost-effectiveness of polio eradication, both from an economic and public health point of view. The second study, by Nick Grassly et al from the Imperial College of London, highlights the greater efficacy of the new monovalent oral polio vaccine type 1 (mOPV1) compared with trivalent OPV. For detailed interpretations of both studies, please click here.
- **Immediate injection of cash urgently needed:** By July 2007, the Global Polio Eradication Initiative will have a negative cash flow, which if not addressed will require an immediate reduction in planned polio eradication activities in the remaining infected countries. Even a temporary cutback would result in the reinfection of polio-free areas, delays in outbreak response, a surge in polio-paralyzed children and an increase in overall costs. Insufficient funds at this late stage imperil the entire 20-year eradication effort, as well as related gains in routine childhood immunization, global communicable disease control, preparedness and response, and other child survival and international health activities. For further information, please visit www.polioeradication.org/fundingbackground.asp .
- **WHA to urge intensified polio efforts:** At the upcoming World Health Assembly (WHA) on 14-23 May in Geneva, Member States are expected to adopt a resolution urging an intensification of eradication efforts to rapidly interrupt the remaining chains of indigenous transmission and further limit potential international spread of the virus. In follow-up to the WHO Director-General's (DG's) 28 February Urgent Stakeholder Consultation, a side meeting with key stakeholders is planned in the margins of the WHA, to discuss the DG's final 'Case for Finishing Polio Eradication'. The 'Case' document will summarize the financial and humanitarian benefits of completing polio eradication, and will set the stage for intensive resource mobilization activities to fill the 2007-2008 global funding gap of US$540 million.
- **Polio confirmed in Myanmar:** a polio case is confirmed in Myanmar, the first wild polio in the country since 2000 and is most likely an importation. (See 'Re-infected countries' section below, for further details.)
- **Less type 1 than type 3 polio in 2007:** In 2007, for the first time ever, there are fewer type 1 polio cases than type 3 cases in the endemic areas (see 'Nigeria', 'India' and 'Pakistan' sections below). This suggests that the strategy of large-scale use of monovalent oral polio vaccine type 1 (mOPV1) to prioritize the eradication of this virus, given its historically higher disease burden and potential to spread internationally, is working.

Country Focus

Nigeria

- In 2007, 68 cases have been reported, of which 52 are due to type 3 poliovirus.
- Plans are continuing to integrate the government's National Programme for Immunization (NPI) with the National Primary Health Care Development Agency. All efforts must be undertaken to ensure that such a move does not adversely affect the gains made in polio eradication and routine immunization over the past 12 months.
- The Expert Review Committee on Polio Eradication (ERC) convened in Abuja on 3-4 May. The ERC noted the steep decline (78%) in type 1 polio in 2007 compared to previous year, as well as progress achieved towards strengthening of routine immunization and polio eradication. At the same time, however, the ERC highlighted the need to close the immunity gap in critical northern states (some of which still have 25% of children below five years of age who have never received a dose of OPV), through higher quality immunization campaigns achieving consistently high coverage.
- The next Immunization Plus Days (IPDs) will be held on 23-26 June.

India

- In 2007, 44 cases have been reported. In Uttar Pradesh state, one of only two remaining endemic states (along with Bihar), 17 of the state's 26 cases are due to type 3 poliovirus. No type 1 polio has been reported in the five traditional high-risk districts of western Uttar Pradesh (Moradabad, JP Nagar, Bareilly, Rampur, Badaun), since 2 October 2006.
- Four large-scale immunization campaigns have already been conducted in 2007 with mOPV1. To support campaigns in key high risk districts, WHO surveillance medical officers (SMOs) from polio-free areas are routinely re-deployed.
- A recent campaign on 8 April was made possible in part thanks to a rapid, last-minute effort by polio partners Rotary and the National Polio Surveillance Project (NPSP). During the planning stages of the campaign, it became apparent that a vaccine-shortfall of more than four million doses was going to affect 17 districts in Bihar. To ensure this shortfall was filled in time of the campaign, Rotary arranged for special permission from Union Railway Minister Laloo Prasad Yadav, to transport 3.3 million doses of vaccine from Delhi, Haryana, Punjab and Uttar Pradesh, on the high-speed Rajdhani Express train. At the same time, a Rotary-hired truck took 700,000 doses of vaccine from Lucknow, Uttar Pradesh, to Patna, Bihar.

Afghanistan and Pakistan

- In 2007, in Pakistan, 7 cases have been reported; 1 case has been reported in Afghanistan. In Pakistan, 5 of the 7 cases are due to type 3 polio.
- A joint Afghanistan/Pakistan Technical Advisory Group (TAG) convened in Islamabad on 17-19 April, to review epidemiological and programmatic data. The TAG highlighted that real progress was achieved in 2006, with the virus now limited to known reservoirs that straddle the two countries and which must be tackled together. The TAG's recommendations focused on intensifying efforts in areas of known polio transmission, and increasing access to populations living in insecure areas, semi-autonomous populations and mobile populations.
- In April, Pakistan and Afghanistan coordinated the fourth large-scale immunization campaign of 2007 (following activities in January, February and March), collectively reaching nearly 50 million children under the age of five years. Focus was again on increasing access to populations in border areas and mobile populations. Nomadic routes were mapped, and vaccination points were set up at key gathering places and at major border-crossings.
- Officially launching polio immunization activities in Pakistan, Prime Minister Shaukat Aziz re-affirmed the government's commitment, vowing: "Pakistan is committed to eradicate polio from the country very soon."
- An audio-slideshow of polio vaccination campaigns along the Afghanistan-Pakistan border is available for viewing (and in downloadable format) at www.polioeradication.org .

Re-infected countries

- **Myanmar** is currently planning a targeted polio immunization campaign as a rapid response to a probable importation from neighbouring Bangladesh, and in advance of the onset of the rainy season in July. Three large-scale, internationally-coordinated cross-border campaigns with Bangladesh are being planned, the first of which is to be launched on 14 May. An immediate immunization response has already been conducted, immunizing approximately 50,000 children in/around the immediate geographic vicinity of the index case. Active disease surveillance activities are also ongoing in the area, to rapidly detect any further cases.
- In the **Democratic Republic of the Congo (DR Congo)**, 2 of the 3 outbreaks due to imported poliovirus from **Angola** appear to have been stopped, with expanded outbreak response activities continuing to address the ongoing transmission in Bandundu/Equateur provinces. A total of 12 cases have been reported in DR Congo this year. Although no new cases have been reported from Angola this year, undetected circulation cannot be ruled out due to ongoing subnational surveillance gaps (as confirmed by genetic sequencing of the 2006 cases in Angola and some of the 2007 cases from DR Congo). At an Angola TAG meeting held in April, rapidly filling these surveillance gaps was discussed.
- In the **Horn of Africa**, outbreak response activities are continuing to stop the two known areas of ongoing transmission, in the cross-border area in northern Somalia and the Somali region of Ethiopia, and central Somalia. At a Horn of Africa TAG meeting in April, the need for intensified cross-border activities was highlighted.
- **Niger** and **Nepal** continue to be at particular risk of repeated, isolated polio importations, due to their geographic proximity to endemic areas (northern Nigeria, and Bihar and Uttar Pradesh, India).

The state of polio eradication

The world now has a second and best chance to eradicate polio: almost all outbreaks in re-infected countries after the international spread of 2003-2006 have been stopped. Only four parts of four countries have never interrupted indigenous wild poliovirus transmission: Nigeria, India, Pakistan and Afghanistan. **Global polio eradication depends on the engagement of the leaders of these four countries.**

The tools to eradicate polio are better than ever. The programme now has vaccines which are twice as effective and diagnostic tools that detect and track poliovirus twice as fast.

Policies to minimize the risks and consequences of international spread of poliovirus are now in place: travellers to and from polio-endemic countries are advised to be fully vaccinated before **travel.**

The remaining challenges to a polio-free world are:

1. Rapidly overcoming the remaining operational challenges to reaching every child in the four endemic areas of Nigeria, India, Pakistan and Afghanistan.
2. Rapidly making available the necessary financial resources to fully implement polio eradication strategies.
3. Continue outbreak response activities in the remaining re-infected countries, and minimise the risk and consequences of further international spread of polio.
4. Increasing polio vaccination coverage through routine immunization services.
5. Maintaining high quality AFP surveillance in all countries.

Polio eradication will only succeed if the necessary funds are made available, and with strong political commitment in polio-affected countries. More than 10 million children will be paralysed in the next 40 years if the world fails to capitalize on its >US$5 billion global investment in eradication.

Eradication versus control for poliomyelitis: an economic analysis

Kimberly M Thompson, Radboud J Duintjer Tebbens

Summary

Background Worldwide eradication of wild polioviruses is likely to yield substantial health and financial benefits, provided we finish the job. Challenges in the four endemic areas combined with continuing demands for financial resources for eradication have led some to question the goal of eradication and to suggest switching to a policy of control.

Methods We developed a dynamic model, based on modelling of the currently endemic areas in India, to show the importance of maintaining and increasing the immunisation intensity to complete eradication and to illustrate how policies based on perception about high short-term costs or cost-effectiveness ratios without consideration of long-term benefits could undermine any eradication effort. An extended model assesses the economic implications and disease burden of a change in policy from eradication to control.

Findings Our results suggest that the intensity of immunisation must be increased to achieve eradication, and that even small decreases in intensity could lead to large outbreaks. This finding implies the need to pay even higher short-run costs than are currently being spent, which will further exacerbate concerns about continued investment in interventions with high perceived cost-effectiveness ratios. We show that a wavering commitment leads to a failure to eradicate, greater cumulative costs, and a much larger number of cases. We further show that as long as it is technically achievable, eradication offers both lower cumulative costs and cases than control, even with the costs of achieving eradication exceeding several billion dollars more. A low-cost control policy that relies only on routine immunisation for 20 years with discounted costs of more than $3500 million could lead to roughly 200 000 expected paralytic poliomyelitis cases every year in low-income countries, whereas a low-case control policy that keeps the number of cases at about 1500 per year could cost around $10 000 million discounted over the 20 years.

Interpretation Focusing on the large costs for poliomyelitis eradication, without assessing the even larger potential benefits of eradication and the enormous long-term costs of effective control, might inappropriately affect commitments to the goal of eradication, and thus debate should include careful consideration of the options.

Published Online
April 12, 2007
DOI:10.1016/S0140-6736(07)60532-7

See Online/Comment
DOI:10.1016/S0140-6736(07)60533-9

Kids Risk Project, Harvard School of Public Health, Boston, MA, USA (Prof K M Thompson ScD, R J Duintjer Tebbens PhD); **and Massachusetts Institute of Technology, Sloan School of Management, Cambridge, MA, USA** (K M Thompson)

Correspondence to:
Prof Kimberly M Thompson, Kids Risk Project, Harvard School of Public Health, Boston, MA 02115, USA
kimt@hsph.harvard.edu

Introduction

Economic assessments have prospectively supported the case for poliomyelitis eradication worldwide.[1–3] While preventing hundreds of thousands of cases of paralytic poliomyelitis and premature deaths, the US domestic poliomyelitis vaccination programme also yielded net economic benefits that exceeded US$180 000 million, even without considering the large, intangible benefits associated with avoided fear and suffering.[4] These US net benefits greatly exceed the cumulative global investment of more than $4000 million (with much more contributed at the national level) over nearly 20 years for the Global Polio Eradication Initiative (GPEI) by external donors.[5] We anticipate that retrospective economic analysis of the GPEI will also show substantial net benefits, if eradication is completed.

In addition to these specific analyses for poliomyelitis, numerous other analyses address the questions and issues related to eradication versus control.[6–13] Notably, Barrett[6] emphasised that a disease could be controlled and eliminated locally, but that eradication requires elimination everywhere at the same time, which requires cooperation. Building on that work, Barrett[7] specifically explores the investment in eradication and finds that "maintaining a very high level of control can never be optimal, given the technical feasibility of eradication." This insight is particularly important because it runs counter to the recent suggestion that control should be maintained such that the "annual global number of cases is less than 500" (ie, a policy of high control in perpetuity).[14] Barrett and Hoel[8] explicitly explore the dynamics of poliomyelitis eradication and provide estimates of thresholds for the welfare cost of paralytic poliomyelitis that must be exceeded to justify eradication (shown separately for rich and poor countries). Geoffard and Philipson[9] showed that private markets might have difficulty achieving eradication when the demand for vaccines depends on the prevalence of disease (ie, the demand for vaccine vanishes when prevalence is low enough), and they explore the incentives of various stakeholders. They also show that, for public health expenditures, if the prevalence inversely affects demand for vaccination (ie, perceived benefit of vaccination drops as prevalence decreases) then this leads to a failure to eradicate.

The GPEI succeeded in reducing yearly cases of paralysis from wild polioviruses from an estimated 350 000 cases in 1988 to about 2000 cases in 2006.[15]

than 5 years) at roughly the same rate,[30] motivated us to simplify to a single-age-cohort model. Since Uttar Pradesh and Bihar clearly represent a geographic area in which polioviruses show high transmissibility, we assume an R_0 of 16 (a theoretical measure that represents the average number of secondary infections introduced by one infectious person in a fully susceptible population).[35] Currently, the relatively low incidence of paralytic poliomyelitis in Uttar Pradesh and Bihar compared with its current population size suggests that the average aggregate oral poliovirus vaccine immunisation intensity has been close to the threshold ($\hat{u}$) necessary to eradicate polioviruses from this population.[44] We explore the effects of changes in u on the burden of paralytic cases.

Building on the insights of others,[7–9] we extend the Uttar Pradesh and Bihar model to explore the implications of adding a constraint of tolerable cost-effectiveness ratio (in $ per paralytic case). We implement this extension by use of a decision rule that substantially reduces immunisation intensity (ie, setting u to a value below $\hat{u}$) as soon as the perceived cost-effectiveness ratio reaches the tolerable cost-effectiveness ratio compared with a decision rule that ceases vaccination after the prevalence of infection drops below 1 (ie, eradication). We define the perceived cost-effectiveness ratio as the yearly vaccination costs corresponding to a particular immunisation intensity divided by the perceived yearly incidence of paralytic cases. The perceived incidence equals the true incidence with a 1-year delay, which represents the time taken to recognise changes in incidence and react by changing the immunisation intensity. This model starts at the pre-vaccine equilibrium. For these and subsequent analyses, we report costs in US$ (2002) and discount costs and cases over time using a 3% rate following standard methods.[45]

To extend the insights obtained from these modelling efforts to a broader region and the larger debate about eradication versus control, we explored the meaning of control compared with eradication for the group of

	Routine vaccination	SIA rounds per year	Surveillance	Response	Population immunity	
					At outset	Heterogeneity*
Theoretical control scenarios (shown in figure 5A)						
No control	None	None	Passive	No response	NA	NA
Very low control	OPV	None	Passive	No response	NA	NA
Very high control†	OPV	Two	AFP‡	Very aggressive‡	NA	NA
Extreme control§	IPV	None	AFP	NA	NA	NA
Modelled control scenarios (shown in figure 5B)¶						
0	OPV	None	Passive	No response	Realistic	None
1	OPV	None	Passive	2 x tOPV, delay 180 days	Realistic	None
2	OPV	None	AFP	2 x tOPV, delay 180 days	Realistic	None
3	OPV	None	Passive	3 x mOPV, delay 120 days	Realistic	None
4	OPV	None	AFP	3 x mOPV, delay 120 days	Realistic	None
5	OPV	Two in three years ‖	Passive	No response	Maximum	High
6	OPV	Two in three years ‖	Passive	2 x tOPV, delay 180 days	Maximum	High
7	OPV	Two in three years ‖	Passive	3 x mOPV, delay 120 days	Maximum	High
8	OPV	One	Passive	No response**	Maximum	Medium
9	OPV	Two ‖	Passive	No response††	Maximum	Low
Post-eradication options (shown in figure 5B)						
No routine	None	None	Passive	3 x mOPV, delay 45 days	Realistic	None
IPV	IPV	None	Passive	3 x mOPV, delay 45 days	Realistic	None
OPV	OPV	None	Passive	3 x mOPV, delay 45 days	Realistic	None
OPV +SIAs	OPV	1‡‡	Passive	3 x mOPV, delay 45 days	Maximum	Medium

SIA=supplemental immunisation activity. OPV=oral poliovirus vaccine. AFP=acute flaccid paralysis. IPV=inactivated poliovirus vaccine. tOPV=trivalent oral poliovirus vaccine. mOPV=monovalent oral poliovirus vaccine. *Column indicates different distributions for the probability of population immunity reduction from the income group average population immunity for a given importation outbreak. With the distribution noted as probability (no reduction, 2-fold increase in proportion effective susceptible, 3-fold increase in proportion effective susceptible), the different reduction levels are: none=probability (1, 0, 0); low=probability (0·9, 0·1, 0); medium=probability (0·75, 0·25, 0·05); and high=probability (0·6, 0·3, 0·1). †Option includes costs of two yearly SIAs in all non-endemic low-income countries and six yearly SIAs in endemic areas. ‡Surveillance and response costs included in $280 million annual costs of maintaining A in the endemic areas. §This extreme scenario includes costs for a universal campaign with two doses of IPV attaining 100% coverage among all people (including adults) to ensure immunity for all individuals at the outset in addition to 100% coverage with three inactivated poliovirus vaccine doses throughout the 20-year time horizon. ¶Assuming effective control that costs $280 million per year to maintain A=1300 cases in endemic areas per year (see webappendix for effect of reductions in the goal for endemic cases A), plus the costs and cases associated with the strategies in non-endemic areas listed here. ‖Assuming the two rounds occur in a paired fashion at a 30-day interval. **Assuming the next single tOPV SIA round starts 180 days after virus introduction. ††Assuming next two tOPV SIA rounds start 165 days after virus introduction. ‡‡For post-eradication scenarios, we modelled the number of rounds probabilistically to account for uncertainty in the future frequency using a triangular distribution with a mean close to 1.

Table: **Scenarios and key assumptions**

to an average of around 1300 per year during the past 5 years,[15] which implies for this scenario that A=1300.[15] With respect to more realistic modelled control scenarios (table), we characterise a range of possible control scenarios for the non-endemic areas, and added to these the costs and cases associated with very high control that keeps endemic cases at A.

We assume that during the next few years the current high intensity of supplemental immunisation activities, aggressive outbreak control, and robust surveillance of acute flaccid paralysis will continue, and thus the time horizon begins at the point when cases drop to A, which might imply additional costs and time to get from the current incidence to any lower A (eg, fewer than 500 cases as has been suggested by others[14]). The eradication options begin with complete interruption of poliovirus transmission and include four future vaccination policies for the post-eradication world (ie, no routine immunisation, routine oral poliovirus vaccination with supplemental immunisation activities, routine oral poliovirus vaccination without supplemental immunisation activities, or routine inactivated poliovirus vaccination). We do not include any additional costs of eradication for these options so that we can explore the amounts that we should be willing to pay to finish eradication when comparing these options to the control options. The total number of paralytic poliomyelitis cases includes wild poliovirus cases in endemic areas as well as importations into areas previously free of wild poliovirus transmission for each control scenario, cases of vaccine-associated paralytic poliomyelitis for any scenarios that use routine oral poliovirus vaccine, supplemental immunisation activities, or outbreak response, and cases from outbreaks of circulating vaccine-derived poliovirus for all scenarios.

Results

Based on modelling the recent experience in northern India, we show the effects of changing the intensity of immunisation (u) with respect to paralytic incidence. Figure 1 shows that u must be increased to achieve eradication and that the relative amount of increase determines the time until eradication. Even small reductions of u from the immunisation intensity required for eventual eradication $\hat{u}$ could lead to rapid accumulation of susceptible people and result in many paralytic cases (figure 2). For example, a reduction of only 10% in u leads to more than 110 000 cumulative paralytic cases over 20 years (ie, more than 5000 cases per year on average), and a reduction by 50% leads to around 500 000 cases. The greater the reduction away from $\hat{u}$, the larger the oscillations toward a new equilibrium, with the possibility of a large outbreak in the second or third year following the change in u (figure 3). These results suggest that greater intensity of effort will be needed, which in the short-run will increase the perception of high costs and cost-effectiveness ratios.

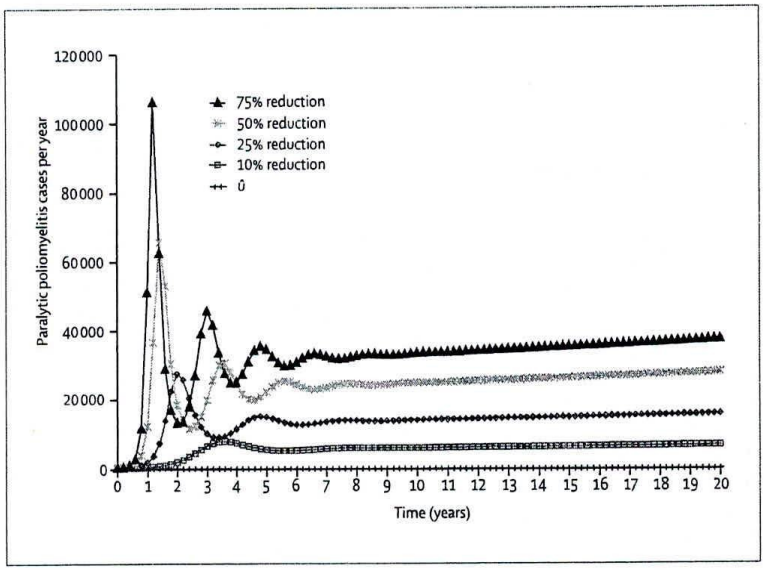


Figure 3: **The incidence of paralytic cases per year in the Indian states of Uttar Pradesh and Bihar with u equal to or less than the threshold ($\hat{u}$) needed for eventual eradication**

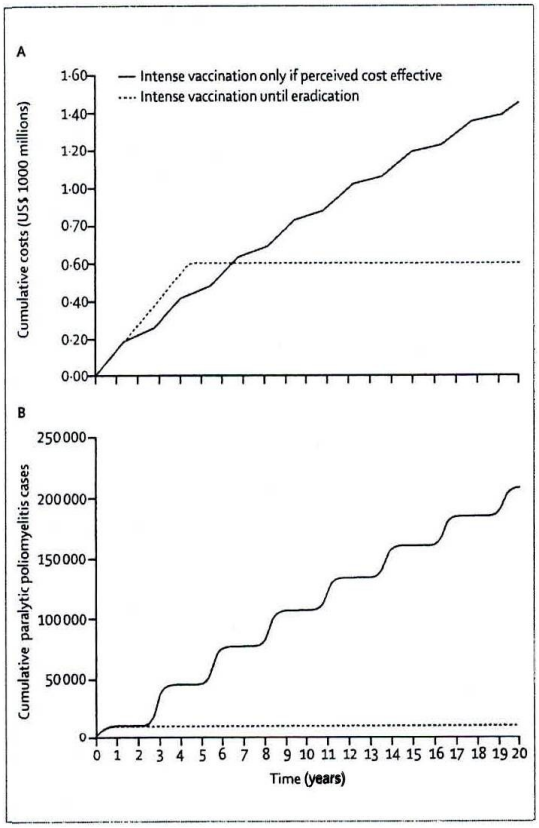


Figure 4: **Cumulative costs and cases in Uttar Pradesh and Bihar for a strategy of pursuing eradication versus intense vaccination only while the perceived cost-effectiveness ratio (PCER, $ per case) remains below the tolerable cost-effectiveness ratio (TCER, $ per case)**
(A) Cumulative costs. (B) Cumulative paralytic cases.

number of cases achievable for a given investment of costs in control), the actual kinetics are uncertain, and will depend on the assumptions. Nonetheless, we find that the realistic control scenarios all imply costs and cases that far exceed the eradication options despite assuming the challenging objective of actually controlling transmission to keep the number of endemic cases below *A*. Low cost options (ie, implying low control) will lie in the region to the right and slightly below the very low control theoretical bound.

The control scenario with no supplemental immunisation activities and no outbreak response (labelled with a 0 in figure 5B) is the model equivalent of the theoretical very low control scenario, except that it assumes higher costs in the endemic areas to keep endemic cases below *A* and thus falls below and to the right of the theoretical bound. On the other end of the scale, the control scenario with two rounds of supplemental immunisation activities per year and no outbreak response (labelled with a 9 in figure 5B) lies above the corresponding theoretical bound of very high control, because some possibility exists of circulating vaccine-derived polioviruses or outbreaks of wild poliovirus in the non-endemic areas even with frequent supplemental immunisation activities, while both assume *A* cases per year in the endemic areas at the same cost. The difference in costs stems from a different assumption about surveillance in the non-endemic areas (table 1). Increasing *A* moves the control options left and up, which translates into lower cost but more cases. The very low control scenario yields a total of more than 3 million discounted cases over the 20-year time horizon, or about 200 000 cases per year.

Finally, we can also assess the difference in the net benefits of a selected eradication option (eg, no routine immunisation after eradication) and the best possible control option as a function of the societal willingness to pay to prevent a case, and view the difference as the amount that we should be willing to spend to achieve eradication. This analysis implies that for a willingness to pay of $5300 per paralytic poliomyelitis case, we should be willing to invest more than $8000 million to achieve eradication based on analysis of low-income countries alone and a 20-year time horizon.

Discussion

Our analysis of low-income countries suggests that eradication is always a better option than control, and that we should be willing to pay thousands of millions of dollars more to achieve this goal. Although we intentionally focused most of our analysis on the low-income countries because they will incur most of the burden of cases if eradication fails, all nations will continue to incur financial costs, implying that the true global willingness to pay is even higher. By contrast, for any low-control scenario we will probably see a disease burden approaching the implied equilibrium number seen in 1988 of 350 000 cases for a worldwide population of 5000 million people.[49] Although the rate with which the number of cases would increase would depend on how quickly the percentage of the population immune to disease declines, our results suggest that low control would ultimately lead to a world with many hundreds of thousands of children paralysed every year (ie, approaching the theoretical bound of very low control), while still needing a sustained financial investment in poliovirus vaccination and treatment. We characterised numerous options for high control, and we note that they all lead to very high costs, which would be difficult to sustain in view of the challenges that exist in closing the financial gaps for eradication now. The GPEI faces financial challenges in the face of large potential savings of both costs and cases. The world is unlikely to support high control in the absence of these potential savings. Thus, our results suggest a very strong economic and public health case for completing poliovirus eradication now.

We believe that focusing on the large costs for poliomyelitis eradication in the absence of estimates of the even larger potential benefits of eradication and the enormous long-term costs of effective control might inappropriately affect commitments to the goal of eradication. This concern is particularly important in view of the reality of constraints on financial resources, many competing opportunities for resources, and the cognitive challenges that arise in considering stocks and flows.[50] Short-term thinking often prevails. As a result we are overly affected by the state of the world now, we fail to adequately account for the state of the world that will follow, and we misunderstand how much the choices we make now will determine our future options and opportunites.[51] In the context of poliomyelitis eradication, we only face the choice of eradicating now because the global investment thus far has produced enough immune people to make worldwide simultaneous elimination of wild polioviruses possible. Thus, the investment in eradication led to high levels of population immunity that might not be fully recognised by many people.[50,51] Assuming that we could later simply pay the same financial amount to finish the job represents a cognitive fallacy.[51]

Our analysis suggests that we either complete eradication now, or pay much more (and risk that we might not have another chance) to try to do so later, while continuing to cumulate both costs and cases. Although economic models suggest that when eradication is desirable it should happen instantly,[8] we acknowledge the real and important social, logistical, and managerial challenges that exist and we emphasise that they could unfortunately lead to a failure to achieve the optimum outcome of eradication when combined with concerns about current high costs or cost-effectiveness. Our results suggest that stakeholders in the debate about whether to give up or pursue the current option to eradicate the poliovirus should make

24 Duintjer Tebbens RJ, Pallansch MA, Kew OM, et al. Risks of paralytic disease due to wild or vaccine-derived poliovirus after eradication. *Risk Analysis* 2006; **26**: 1471–1505.

25 Henderson DA. Countering the posteradication threat of smallpox and polio. *Clin Infect Dis* 2002; **34**: 79–83.

26 Kew OM, Wright PF, Agol VI, et al. Circulating vaccine-derived polioviruses: current state of knowledge. *Bull World Health Organ* 2004; **82**: 16–23.

27 Aylward RB, Sutter RW, Cochi SL, Thompson KM, Jafari H, Heymann DL. Risk management in a polio-free world. *Risk Analysis* 2006; **26**: 1441–48.

28 Aylward RB, Sutter RW, Heymann DL. OPV cessation—the final step to a "polio-free" world. *Science* 2005; **310**: 625–26.

29 Dowdle WR, Birmingham ME. The biologic principles of poliovirus eradication. *J Infect Dis* 1997; **175** (suppl 1): S286–92.

30 Grassly NC, Fraser C, Wenger J, et al. New strategies for the elimination of polio from India. *Science* 2006; **314**: 1150–53.

31 World Health Organization. Progress towards poliomyelitis eradication in India, January 2005 to June 2006. *Wkly Epidemiol Rec* 2006; **81**: 286–91.

32 World Health Organization. Conclusions and recommendations of the Advisory Committee on Poliomyelitis Eradication, Geneva, 11–12 October 2006, Part I. *Wkly Epidemiol Rec* 2006; **81**: 453–60.

33 Henderson DA. Eradication: lessons from the past. *MMWR Morb Mortal Wkly Rep* 1999; **48**: 16–22.

34 Sangrujee N, Duintjer Tebbens RJ, Cáceres VM, Thompson KM. Policy decision options during the first 5 years following certification of polio eradication. *Medscape Gen Med* 2003; **5**: 35.

35 Duintjer Tebbens RJ, Pallansch MA, Kew OM, Cáceres VM, Sutter RW, Thompson KM. A dynamic model of poliomyelitis outbreaks: learning from the past to help inform the future. *Am J Epidemiol* 2005; **162**: 358–72.

36 Duintjer Tebbens RJ, Sangrujee N, Thompson KM. The costs of polio risk management policies after eradication. *Risk Analysis* 2006; **26**: 1507–31.

37 Thompson KM, Duintjer Tebbens RJ, Pallansch MA. Evaluation of response scenarios to potential polio outbreaks using mathematical models. *Risk Analysis* 2006; **26**: 1541–56.

38 World Bank. World Bank list of economies (July 2002). http://www.worldbank.org/data/databytopic/CLASS.XLS (accessed December, 2002).

39 Census of India 2001. Population projections for India and states 2001–2026. New Dehli, 2006.

40 South East Asia Regional WHO Office. VPD Surveillance Bulletin. http://www.searo.who.int/EN/Section1226/showfiles.asp (accessed Jan 30, 2007).

41 Eastern Mediterranean Regional WHO Office. Polio Fax. http://www.emro.who.int/Poliofax/ (accessed Jan 30, 2007).

42 Office ARW. Wild Poliovirus Information for 2005, WHO/African Region. http://www.afro.who.int/polio/surveillance_maps/wp2005.html (accessed Jan 30, 2007).

43 World Health Organization. Polio case count. http://www.who.int/vaccines/immunization_monitoring/en/diseases/poliomyelitis/case_count.cfm (accessed Jan 30, 2007).

44 Anderson RM, May RM. Infectious diseases of humans: dynamics and control. New York: Oxford University Press, 1991.

45 Gold MR, Siegel JE, Russel LB, Weinstein MC. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.

46 Centers for Disease Control and Prevention. Resurgence of wild poliovirus type 1 transmission and consequences of importation—21 previously polio-free countries, 2002–2005. *Morb Mortal Wkly Report* 2006; **55**: 145–50.

47 Kimman TG, Boot H. The polio eradication effort has been a great success—let's finish it and replace it with something even better. *Lancet Infect Dis* 2006; **6**: 675–78.

48 World Health Organization. Unpublished projections: Department of Immunization Vaccines and Biologicals, 2004.

49 UN Population Division. World population prospects population database: the 2002 revision population database. http://esa.un.org/unpp/index.asp?panel=2 (accessed July 31, 2003)

50 Sterman J. Misperceptions of feedback in dynamic decision making. *Organ Behav Human Decision Proc* 1989; **43**: 301–35.

51 Sterman J. Business dynamics: systems thinking and modeling for a complex world. Boston: McGraw-Hill, 2000.

52 Fenner F, Henderson DA, Arita I, et al. Smallpox and its eradication. Geneva: World Health Organization, 1988.

The World Health Organization

The Case for Completing Polio Eradication

'As an international community, we have few opportunities to do something that is unquestionably good for every country and every child, in perpetuity.'

Dr Margaret Chan
Director-General
World Health Organization

The Issue

Without an urgent infusion of international funds, the opportunity to complete polio eradication could be lost forever...

By July 2007 the Global Polio Eradication Initiative (GPEI) will have a negative cash flow, which if not addressed will require an immediate reduction in planned polio eradication activities in the remaining infected countries[1]. Even a temporary cutback would result in the reinfection of polio-free areas, delays in outbreak response, a surge in polio-paralyzed children and an increase in overall costs. Insufficient funds at this late stage imperil the entire 20-year eradication effort, as well as related gains in routine childhood immunization, global communicable disease control, preparedness and response, and other child survival and international health activities.

The following 'case statement' was developed following an 'Urgent Stakeholder Consultation on Polio Eradication' convened by the Director-General of the World Health Organization (WHO) on 28 February 2007 at the WHO Headquarters in Geneva, Switzerland. The list of participants, agenda, presentations and other related materials from the Consultation are available at www.polioeradication.org.

---

[1] At 10 May 2007, 4 countries had yet to stop indigenous poliovirus (i.e. 'endemic' countries: Afghanistan, India, Nigeria, Pakistan); 6 of the 26 countries reinfected since 2003 by virus that originated in an endemic country had not yet stopped transmission again (i.e. Angola, Bangladesh, Democratic Republic of the Congo, Ethiopia, Myanmar, Somalia); 4 additional countries that border 'endemic' areas continue to suffer sporadic importations (i.e. Cameroun, Chad, Nepal, Niger).

The Context

In 1988, over 350 000 children were being paralyzed by polio every year...

Despite the availability of an effective, cheap, oral polio vaccine (OPV) for more than 25 years, over 350 000 children in at least 125 countries were still being permanently paralyzed by wild polioviruses[2] each year when the Global Polio Eradication Initiative (GPEI) was launched in 1988.

By 1999, the GPEI had reduced annual polio cases by 99% and proven the feasibility of eradication...

The technical feasibility of eradicating wild-type poliovirus was confirmed in October 1999 when the last case of paralytic polio due to wild poliovirus type 2 (1 of 3 types) was detected anywhere in the world. By 2002, the feasibility of eradication was reaffirmed by certification of eradication of all 3 wild poliovirus types in 3 of the 6 WHO Regions.

In 2003, limited cutbacks in eradication activities led to a huge resurgence of polio...

In mid-2003 two northern Nigeria states that were heavily infected with polio unexpectedly suspended OPV use (stating it might be 'contaminated'), leading to a national epidemic[3]. This occurred shortly after the GPEI shifted tactics, in part due to limited financing, stopping campaigns in most polio-free areas of Africa, Asia and the Middle East to focus resources on endemic countries. Since 2003, 20 polio-free countries in these areas have suffered new outbreaks following importations of a poliovirus from Nigeria while virus originating in India re-infected another 6 countries. In total, thousands of children in polio-free areas were paralyzed, requiring the additional expenditure of over US$ 450 million for emergency response activities.

In 2006, 4 countries still had indigenous poliovirus, prompting some to propose that eradication be abandoned...

Citing the high costs of completing polio eradication relative to the low number of remaining cases, and suggesting the last 4 endemic countries and some re-infected countries could not fully implement the strategies, some public health officials proposed the eradication goal be abandoned for one of 'effective control'. This proposal was made amid increasing international awareness and discussion of other risks, such as the fatigue of health workers and volunteers after years of campaigns, historical gaps in surveillance quality and competing development priorities.

---

[2] 'Wild' denotes naturally occurring polioviruses which circulate(d) among humans. 'Sabin-strain' denotes the attenuated polioviruses that are used to make oral poliovirus vaccine (OPV).

[3] Centers for Disease Control and Prevention. Resurgence of wild poliovirus type 1 transmission and consequences of importation into 21 previously polio-free countries, 2002-2005. *Morbidity and Mortality Weekly Report* 2006; 55: 145-50.

The Case for Completing Polio Eradication

A new study shows switching to polio 'control' would actually cost more than completing eradication...

Advocates of 'effective control' (which they define as maintaining <500 polio cases/year indefinitely) predicted this could be achieved at lower costs than completing eradication[4]. However, an independent analysis found that 'effective control' would actually result in a much higher burden of disease and at costs that would exceed, by billions of dollars over a 20-year period, those of completing eradication[5].

New analyses confirm that returning to routine immunization alone for polio control would result in over 200 000 children again paralyzed by polio each year...

The international spread of polio from Nigeria in 2003 showed that the number of cases could increase very rapidly if eradication were not completed[3]. New mathematical models found that regardless of the control strategy, in low-income countries alone a switch to 'control' would result in up to 4 million polio-paralyzed children over the next 20 years[5]. This increase in polio would disproportionately affect poor populations, with the vast majority of cases occurring in countries with a GDP of < US$ 1000/year.

New tools greatly enhance the impact of the eradication strategies[6]...

A recent study confirms that new polio vaccines ('monovalent OPVs' or 'mOPVs'), developed by an extraordinary public-private partnership in 2005-6, substantially enhance the impact of polio campaigns[7]. Dose for dose, these vaccines more than double a child's protection against the specific type of polio present in a country, as compared with the traditional trivalent OPV. GPEI is also assessing the potential role of inactivated polio vaccine (IPV) in case polio is found to persist in an area with very high mOPV coverage.

New measures are reducing the risk and consequences of new outbreaks in polio-free areas...

Since the World Health Assembly in 2006 endorsed faster, larger and more sustained polio outbreak responses, only 6% of new cases have been due to importations, compared with 52% in 2005. The speed of outbreak response activities has been

---

[4] Arita I. Public health. Is polio eradication realistic? *Science* 2006; 312(5775): 852-4.

[5] Thompson KM, Tebbens RJ. Eradication versus control for poliomyelitis: an economic analysis. *Lancet*. 2007; 369(9570): 1363-71.

[6] GPEI's 4-pronged strategy (routine immunization, National Polio Immunization Days (NIDs), acute flaccid paralysis (AFP) surveillance, and 'mop-ups') used trivalent oral poliovirus vaccine (tOPV).

[7] Grassly NC. Protective efficacy of a monovalent oral type 1 poliovirus vaccine: a case-control study. *Lancet*. 2007; 369(9570): **1356-62.**

further enhanced by new laboratory methods introduced in late 2006 to reduce by 50% the time needed to confirm polio infections and, since 2005, a doubling of surveillance sensitivity performance targets in all high-risk countries.

New tactics are tailored to address the specific challenges in the last 4 endemic countries...

By late 2006, 'Immunization Plus Days' (IPDs) in Nigeria were combining mOPV with other interventions, substantially increasing routine immunization coverage, community acceptance and political support. In India, a new accelerated mOPV campaign schedule is boosting young child immunity more rapidly than in 2006. In Pakistan and Afghanistan, a new, multi-pronged approach includes cross-border synchronization of campaigns, tracking of nomad populations and negotiating access with local leaders and military forces. In all 4 countries, religious and traditional leaders have substantially increased their role to better engage local communities.

In the last 4 endemic countries, the Head of Government is now directly engaged in completing eradication ...

On 28 February 2007, the Heads of Government of Afghanistan, India, Nigeria and Pakistan sent personal envoys to lead their delegations to the Director-General's *Urgent Stakeholder Consultation on Polio Eradication* at WHO, Geneva. This level of government can marshal cross-ministerial, cross-sectoral support for new tactics to reach every child in each infected area. In 2 of the 4 countries the impact of this support is already evident in new pledges totalling US$ 311 million in domestic financing for polio activities.

Completing eradication will benefit the Millennium Development Goals (MDGs)...

The investment in GPEI pays major dividends beyond preventing 5 million polio cases to date. Over 85% of the fulltime GPEI staff (approximately 3 400 people at 1 May 2007) work on other disease control activities for an average of 50% of their time. This GPEI investment has helped avert 1.25 million deaths through Vitamin A supplementation and 2.3 million deaths through measles mortality reduction activities[8]; boost routine immunization and introduce new vaccines in GAVI-eligible countries; respond to international health emergencies such as SARS and Avian Influenza[9]; and facilitate a rapid response to humanitarian crises such as the South Asia Tsunami in 2004 and the Pakistan earthquake in 2005. Further investing in eradication will facilitate the continued integration of the GPEI's infrastructure and operations with other activities, and prevent the harmful consequences of an inadvertent collapse in GPEI **support.**

---

[8] Wolfson LJ. Measles Initiative. Has the 2005 measles mortality reduction goal been achieved? A natural history modelling study. *Lancet* 2007; 369(9557): 191-200.

[9] Heymann DL, Aylward RB. Poliomyelitis eradication and pandemic influenza. *Lancet* 2006; 367(9521): 1462-4.

Immediate Actions to Intensify Polio Eradication Efforts (within 6 months)

Exploiting the new tools, tactics and commitments to accelerate polio eradication during 2007-8 requires immediate action by all GPEI stakeholders. For endemic countries, the priority is to increase the number of children vaccinated with the new mOPVs in each polio-infected district during each campaign. At the international level, the focus is on ensuring the GPEI has the financing and political support needed to implement polio campaigns and surveillance of the highest possible quality.

National activities (polio-endemic countries)

1. *Polio as a National Priority:* a government mechanism will be established at national and state/province levels to coordinate cross-ministerial and cross-sectoral inputs regularly (at least every 2 months) and report to the head of government. 'Polio officers' will implement the decisions of these bodies, with overall responsibility for performance in their area.

2. *Social Mobilization & Communications:* a national-international review will develop a comprehensive plan of action to engage communities in infected districts, optimize mass media use, increase the role of local influencers and proactively deal with rumours. Standard indicators will be analyzed during each campaign, with a revision of the plan if appropriate.

3. *Campaign Quality & Monitoring:* to reach >95% of children in infected districts, microplans will be redone to international standards with all areas mapped and assigned to vaccinators acceptable to the community; local organizations and NGOs will be engaged, especially religious and women's groups. Independent teams will monitor campaigns in high-risk areas[10] and report to the national polio technical advisory body. In infected districts, areas achieving <90% coverage will be revisited and **revaccinated.**

4. *Routine Immunization:* coverage targets will be established for polio-infected districts and, with key process indicators[11], included in data reviewed during each meeting of national technical advisory body.

5. *Research & Introduction of New Tools:* research to guide activities (e.g. serosurveys, IPV studies, pilots of new interventions) will be identified by technical advisory bodies and addressed within 6 months. New tools will be rapidly introduced (e.g. by licensing at least 2 of each mOPV1 and mOPV3).

6. *Domestic Financing:* 3-year eradication budgets will be established or updated, domestic financing will be finalized, and a high-level national Interagency Coordinating Committee (ICC) meeting will be convened 2 times per year with development partners and the Ministry of Finance to discuss or clarify domestic financing.

---

[10] Highest risk areas for missing children during polio campaigns, as identified by a high burden of disease, a high proportion of 'never vaccinated children', historically poor campaign performance, etc.

[11] Key process indicators may include the proportion of routine immunization positions that are vacant, routine immunization sessions conducted and vaccine stockouts.

International activities (donors and partner agencies)

1. *International Financing:* development partners will include the *'Case for Completing Polio Eradication'* in G8 meetings, meetings of the OECD-DAC, the World Bank Development Committee, the Organization of Islamic Conference (OIC) and Boards of the Global Alliance for Vaccines and Immunization (GAVI).

2. *International Advocacy:* the Director-General of WHO will travel to each of the 4 endemic countries to discuss the intensified eradication effort with the Head of Government. The *'Case for Completing Polio Eradication'* will also be brought to the attention of the political leaders and organizations that support the GPEI, through the summits of the G8, the Organization of Islamic Conference (OIC), the African Union, the South Asian Association for Regional Cooperation (SAARC) and the Commonwealth.

3. *Enhancing the Safety of Polio Workers & Volunteers:* WHO, UNICEF and relevant international stakeholders will assist national efforts to advocate for Days of Tranquillity and/or other mechanisms to ensure the safe passage of vaccinators to reach all children in insecure areas and areas of active conflict.

4. *International Coordination of Campaigns:* WHO and UNICEF will assist countries to synchronize campaigns where this is needed to optimize coverage of moving populations (e.g. Afghanistan/Pakistan, India/Nepal, Nigeria/Niger).

5. *Limiting International Spread of Polio:* WHO and UNICEF will assist reinfected countries to implement rapid responses to polio outbreaks. WHO will also assist in updating national immunization policy to reduce the risk of polio importations.

Milestones for an Intensified Polio Eradication Effort

Progress towards the following milestones will demonstrate whether the 'immediate actions for an intensified eradication effort' are being implemented and achieving the expected impact on stopping polio transmission in endemic and reinfected countries.

1. Endemic Countries: Reduction in Polio-Infected Districts

   - by end-2007 there should be a 50% reduction in the number of polio-infected districts relative to 2006.

   - by end-2008 polio transmission should be interrupted *or* there should be at least a further 50% reduction in the number of infected districts relative to 2007.

2. Endemic Countries: Increase in Protection Against Polio in Infected Districts[12]

   - by end-2007 the level of immunity against polio among children aged 6-35 months in infected districts should be at least at the level in polio-free districts.

   - by end-2008 the level of polio immunity among children aged 6-35 months in infected districts should have been at least as high as in polio-free districts, for at least 12 months.

3. Reinfected Countries: Rapid Cessation of New Polio Outbreaks

   - by end-2007, countries reinfected in 2006 will have implemented appropriate response activities[13] and interrupted transmission of the imported poliovirus.

   - by end-2008, any country reinfected in 2007 will have implemented response activities and interrupted transmission of the imported poliovirus.

4. International Stakeholders: Closure of the Financing Gap[14]

   - by mid-2007 sufficient funding will have been pledged to finance all eradication activities planned through end-2007.

   - by end-2007 sufficient funding will have been pledged to finance all eradication activities planned through end-2008.

---

[12] Measured by the vaccination status of non-polio acute flaccid paralysis (AFP) cases aged 6-35 months and, if appropriate, adjusted for differences in vaccine efficacy compared with polio-free areas.

[13] World Health Assembly Resolution WHA59.1.

[14] As outlined in the relevant edition of the Financial Resource Requirements of the Global Polio Eradication Initiative (FRRs) at www.polioeradication.org.

Monitoring the Intensified Polio Eradication Effort

Stakeholders can monitor progress towards the milestones and activities of the intensified eradication effort on the GPEI website www.polioeradication.org, and in GPEI publications (e.g. PolioNews and the GPEI Annual Report).

In each endemic country, activities will be monitored and guided every 4-6 months by the polio technical advisory body (the Expert Review Committee (ERC) in Nigeria; the Technical Advisory Group (TAG) in Afghanistan and Pakistan; and the India Expert Advisory Group (IEAG)). At the international level, activities will be monitored by the Advisory Committee on Polio Eradication (ACPE) every 6 months (with a face-to-face meeting every 12 months) and by regional advisory committees each year.

The findings of the technical advisory bodies will be posted on the GPEI website within 10 days of each meeting and will be reflected in the annual reports of the Secretariat to the World Health Assembly. Follow-up stakeholder consultations will be convened every 12 months.

A Call to Action to Finance an Intensified Eradication Effort, 2007-8

Implementing the 'immediate actions' to intensify the GPEI requires a rapid injection of multi-year flexible funding, without which the opportunity to eradicate polio will be lost. As of 10 May 2007, the GPEI had a funding gap of US$ 540 million for 2007-8. Activities and staff will have to be cut back as early as July 2007 if US$ 100 million of the funding gap is not secured by that time. A further US$ 100 million of the funding gap requirement is needed by November 2007.

Summary of external financing required by major category of expenditure, 2007-8 (US$ millions)[15]

Major Expenditures	2007	2008	2007-2008
Oral polio vaccine	$ 227.98	$ 176.09	$ 404.07
Campaign operations	$ 230.69	$ 163.81	$ 394.50
Outbreak response/ mOPV evaluation	$ 50.00	$ 35.00	$ 85.00
Surveillance	$ 61.09	$ 59.47	$ 120.56
Laboratory	$ 8.37	$ 8.45	$ 16.82
Technical assistance	$ 87.90	$ 83.35	$ 171.25
Certification and containment	$ 12.00	$ 12.00	$ 24.00
Products for the post-eradication era	$ 5.00	$ 5.00	$ 10.00
Vaccine for post-eradication stockpile	$ 12.70	$ 31.60	$ 44.30
Subtotal	**$ 695.72**	**$ 574.77**	**$ 1,270.50**
Contributions	$ 493.80	$ 237.73	$ 731.53
Funding gap	**$ 201.92**	**$ 337.04**	**$ 538.97**

Budget notes:

- conducting additional campaigns to raise immunity in polio-free countries at moderate risk of importations would cost an additional US$ 110 million per year.
- a 12-month delay in completing eradication in the Pakistan/Afghanistan reservoirs, Nigeria or India would increase costs by a minimum of US$ 45 million, US$ 80 million and US$ 140 million, respectively.
- after interrupting wild poliovirus transmission globally, US$ 661 million will be required over the next 3 years for certification and post-eradication preparedness.

[15] Details can be found in the Financial Resource Requirements of the Global Polio Eradication Initiative (FRRs) at www.polioeradication.org .

Protective efficacy of a monovalent oral type 1 poliovirus vaccine: a case-control study

Nicholas C Grassly, Jay Wenger, Sunita Durrani, Sunil Bahl, Jagadish M Deshpande, Roland W Sutter, David L Heymann, R Bruce Aylward

Lancet 2007; 369: 1356–62
Published Online April 12, 2007
DOI:10.1016/S0140-6736(07)60531-5

See Comment pages 1321 and 1322
See Articles page 1363

Department of Infectious Disease Epidemiology, Imperial College London, London, UK (N C Grassly DPhil); National Polio Surveillance Project, WHO, New Delhi, India (J Wenger MD, S Durrani BSc, S Bahl MD); Enterovirus Research Centre, Parel, Mumbai, India (J M Deshpande PhD); and Global Polio Eradication Initiative, WHO, Geneva, Switzerland (R W Sutter MD, D L Heymann MD, R B Aylward MD)

Correspondence to: Dr Nicholas C Grassly, Department of Infectious Disease Epidemiology, Imperial College London, Norfolk Place, London W2 1PG, UK
n.grassly@imperial.ac.uk

Summary

Background A high-potency monovalent oral type 1 poliovirus vaccine (mOPV1) was developed in 2005 to tackle persistent poliovirus transmission in the last remaining infected countries. Our aim was to assess the efficacy of this vaccine in India.

Methods We estimated the efficacy of mOPV1 used in supplementary immunisation activities from 2076 matched case-control pairs of confirmed cases of poliomyelitis caused by type 1 wild poliovirus and cases of non-polio acute flaccid paralysis in India. The effect of the introduction of mOPV1 on population immunity was calculated on the basis of estimates of vaccination coverage from data for non-polio acute flaccid paralysis.

Findings In areas of persistent poliovirus transmission in Uttar Pradesh, the protective efficacy of mOPV1 was estimated to be 30% (95% CI 19–41) per dose against type 1 paralytic disease, compared with 11% (7–14) for the trivalent oral vaccine. 76–82% of children aged 0–23 months were estimated to be protected by vaccination against type 1 poliovirus at the end of 2006, compared with 59% at the end of 2004, before the introduction of mOPV1.

Interpretation Under conditions where the efficacy of live-attenuated oral poliovirus vaccines is compromised by a high prevalence of diarrhoea and other infections, a dose of high-potency mOPV1 is almost three times more effective against type 1 poliomyelitis disease than is trivalent vaccine. Achieving high coverage with this new vaccine in areas of persistent poliovirus transmission should substantially improve the probability of rapidly eliminating transmission of the disease.

Introduction

By early 2004, the transmission of indigenous wild poliovirus had been interrupted in all but six countries of the world as a result of a concerted international eradication effort.[1] In four of these countries—Nigeria, Niger, Pakistan, and Afghanistan—sustained transmission was the result of a failure to immunise a sufficiently high proportion of children against poliomyelitis.[2] However, In India and Egypt, poliovirus transmission persisted despite immunisation coverage with four doses of the trivalent oral poliovirus vaccine of more than 90% among children aged less than 5 years.[3,4]

In recognition of the grave threat that persistent transmission in India and Egypt posed to the Global Polio Eradication Initiative, the programme's international oversight body urgently reviewed a range of options in October, 2004, to enhance the effectiveness of vaccination in these areas. By that time, transmission of wild type 2 poliovirus had been interrupted worldwide and type 3 poliovirus had been eliminated in Egypt and all but one state of India. Consequently, the Advisory Committee on Polio Eradication recommended the rapid development, licensing, and introduction of a new monovalent oral type 1 poliovirus vaccine (mOPV1).[5] This new vaccine possesses five times the potency of licensed monovalent vaccines used in the early 1960s (1×10^6 median cell culture infective doses [$CCID_{50}$] *vs* 200 000 $CCID_{50}$ per dose).[5] Through an extraordinary public-private development effort this new mOPV1 was licensed by April, 2005, in India and Egypt and used in mass polio immunisation campaigns in India (April, 2005) and Egypt (June, 2005).[6,7]

The efficacy of mOPV1 has major implications for international public health. The Global Polio Eradication Initiative has invested US$5 billion in eradication over a 20-year period and a key role is now proposed for monovalent vaccines in the strategic approach to interrupting the transmission of remaining indigenous wild poliovirus and managing the risks of re-emergent transmission of poliovirus after global certification of eradication.[8,9]

Especially important to the programme is the effectiveness of the monovalent vaccine under field conditions of poor sanitation and high population density, where a high prevalence of diarrhoeal disease and other infections have been shown to interfere with the efficacy of trivalent oral poliovirus vaccine as well as to favour the transmission of wild poliovirus.[10–12] In Egypt, no indigenous strain of wild poliovirus has been detected since the introduction of mOPV1.[6] In India, however, a polio outbreak in 2006 allowed us to study the efficacy of this new vaccine under field conditions. Our aim was to determine the protective efficacy of mOPV1 in India and explore the consequent implications of mOPV1 for global polio eradication and post-eradication risk management.

Methods

Patients and procedures

Since the introduction of mOPV1 use in India in 2005, vaccination efforts have focused on the northern states of

Investigators who enrolled patients

Australia—C Bladin, S Davis, R Gerraty, J Frayna, G Herkes, P Landau, D Crimmins, D Schultz, S Read, G Hankey; Austria—W Soukop, K Niederkorn, E Rumpl, W Lang; Brazil—A A Gabbai, E Ramacciotti, M Friedrich, E R F Manenti, R J Gagliardi; Canada—L Berger, C Bradley, A Mackey, M Mant, G Pineo; Colombia—M I Vergara; Czech Republic—Z Kalita, M Bar, D Vaclavik, R Mikulik, J Neumann, E Ehler, J Bauer, O Skoda; India—M V Padma, C U Velmurugendran, A Patel, V Puri, S Ravat, A Shah, S Prabhakar, R Srinivasa, M Singh, J M K Murthy; Israel—B Brenner, A S Berliner, G Lugassy, M Ellis; Italy—C Fieschi, C Argentino, D Paternostro, G Micieli, D Imberti; Mexico—J L Ruiz-Sandoval, A Arauz, L Leon-Flores, G Aguayo-Leytte, J Villarreal-Careaga, C Cantu-Brito, J A Sagastegui-Rodriguez; Poland—A Czlonkowska, D Filipczak, P Haug, H Kwiecinski, W Nyka, J Pniewski, J Kozlowska-Staniczek, Z Stelmasiak, A Kuczynska-Zardzewialy; South Africa—L Van Zyl, J Steyn, J Engelbrecht, J Gardiner, F Maritz, L Jamjam, H F M Nortje, R Isaacs; South Korea—J K Roh, M K Han, Y S Lee, B C Lee, J H Heo, D I Chang, D J Shin; Turkey—S Bahar, B Ince, G Bakac, K Selekler, K Kutluk, E Ogul, A Ozeren. USA—D Sherman, J Couch, R B Van Staven, H Payne, B Dihenia, R Atkinson, J Bertoni, D Chiu, G Albers, K Levin, J Graff, E Giraldo, N Papamitskas, A Lahiri, M Vengrow, J J Wang, D Wang, E Skalabrin, V D P Bandi, D Honeycutt, A Kay, S Kishner, K Sheinart, M Duerden, A Felix, M Goldstein, P Mazzeo, W O'Riordan, J Rubin, E Albakri, R Dafer, S Etezadi, E Lader, W Felton, A Kloman, D Pasupuleti, S Mallenbaum, J Kramer, M Concha, R Zweifler.

Contributors

All authors participated in the study design, collection of data, interpretation of results, and writing and critically reviewing or revising the report. All authors have seen and approved the final version of the report, and were fully responsible for content and editorial decisions.

Conflict of interest statement

All authors were members of the PREVAIL study steering committee. DS has received honoraria from Sanofi-Aventis for speaker bureau and consultancy. CK has received honoraria for membership of speaker bureaus for Boehringer-Ingelheim and Sanofi-Aventis, and from Organon for consultancy. WO'R was a principal investigator at a study site for both PREVAIL and EXCLAIM studies (sponsored by Sanofi-Aventis). GP has received honoraria from Sanofi-Aventis, Pfizer, BMS, and Leo for consultancy. GA has been a member of scientific advisory boards and a principal investigator in clinical trials funded by AstraZeneca, Sanofi-Aventis, Novartis, and Boehringer Ingelheim.

Acknowledgments

This study was sponsored by Sanofi-Aventis. We thank the people who agreed to participate in this trial and the study contributors, including members of the steering committee. Editorial support for this article was provided by Sanofi-Aventis.

References

1 Feigin VL, Lawes CM, Bennett DA, Anderson CS. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case-fatality in the late 20th century. *Lancet Neurol* 2003; **2:** 43–53.

2 The World Health Organization. The atlas of heart disease and stroke. http://www.who.int/cardiovascular_diseases/en/cvd_atlas_15_burden_stroke.pdf) (accessed March 1, 2007).

3 Thom T, Haase N, Rosamond W, et al. Heart disease and stroke statistics—2006 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2006: **113**: e85–151.

4 Leys D. Atherothrombosis: a major health burden. *Cerebrovasc Dis* 2001: **11** (suppl 2): 1–4.

5 Johnston KC, Li JY, Lyden PD, et al. Medical and neurological complications of ischemic stroke: experience from the RANTTAS trial. RANTTAS Investigators. *Stroke* 1998; **29:** 447–53.

6 Geerts WH, Pineo GF, Heit JA, et al. Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. *Chest* 2004: **126** (suppl 3): 338S–400S.

7 McCarthy ST, Turner J. Low-dose subcutaneous heparin in the prevention of deep-vein thrombosis and pulmonary emboli following acute stroke. *Age Ageing* 1986; **15: 84–88.**

8 McCarthy ST, Turner JJ, Robertson D, Hawkey CJ, Macey DJ. Low-dose heparin as a prophylaxis against deep-vein thrombosis after acute stroke. *Lancet* 1977: **310**: 800–01.

9 Kelly J, Rudd A, Lewis R, et al. Venous thromboembolism after acute stroke. *Stroke* 2001; **32:** 262–67.

10 Adams HP Jr, Adams RJ, Brott T, et al., for the Stroke Council of the American Stroke Association. Guidelines for the early management of patients with ischemic stroke: a scientific statement from the Stroke Council of the American Stroke Association. *Stroke* 2003; **34:** 1056–83.

11 Albers GW, Amarenco P, Easton JD, Sacco RL, Teal P. Antithrombotic and thrombolytic therapy for ischemic stroke: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. *Chest* 2004; **126:** 483S–512S.

12 Nicolaides AN, Fareed J, Kakkar AK, et al. Prevention and treatment of venous thromboembolism International Consensus Statement (guidelines according to scientific evidence). *Int Angiol* 2006; **25:** 101–61.

13 Hack W, Kaste M, Bogousslavsky J, et al. European stroke initiative recommendations for stroke management-update 2003. *Cerebrovasc Dis* 2003; **16:** 311–37.

14 Adams HP Jr, Adams RJ, Brott T, et al. Guidelines for the early management of patients with ischemic stroke: a scientific statement from the Stroke Council of the American Stroke Association. *Stroke* 2003; **34**: 1056–83.

15 Diener HC, Ringelstein EB, von Kummer R, et al, for the PROTECT Trial Group. Prophylaxis of thrombotic and embolic events in acute ischemic stroke with the low-molecular-weight heparin certoparin: results of the PROTECT Trial. *Stroke* 2006; **37:** 139–44.

16 Hillbom M, Erila T, Sotaniemi K, Tatlisumak T, Sarna S, Kaste M. Enoxaparin vs heparin for prevention of deep-vein thrombosis in acute ischaemic stroke: a randomized, double-blind study. *Acta Neurol Scand* 2002; **106:** 84–92.

17 Bath PM, Iddenden R, Bath FJ. Low-molecular-weight heparins and heparinoids in acute ischemic stroke: a meta-analysis of randomized controlled trials. *Stroke* 2000; **31:** 1770–78.

18 Counsell C, Sandercock P. Low-molecular-weight heparins or heparinoids versus standard unfractionated heparin for acute ischemic stroke (Cochrane review). *Stroke* 2002; **33:** 1925–26.

19 Kamphuisen PW, Agnelli G. What is the optimal pharmacological prophylaxis for the prevention of deep-vein thrombosis and pulmonary embolism in patients with acute ischemic stroke? *Thromb Res* 2006; **119:** 265–74.

20 Brott T, Adams HP Jr, Olinger CP, et al. Measurements of acute cerebral infarction: a clinical examination scale. *Stroke* 1989; **20:** 864–70.

21 Lensing AW, Buller HR, Prandoni P, et al. Contrast venography, the gold standard for the diagnosis of deep-vein thrombosis: improvement in observer agreement. *Thromb Haemost* 1992; **67:** 8–12.

22 Rabinov K, Paulin S. Roentgen diagnosis of venous thrombosis in the leg. *Arch Surg* 1972; **104:** 134–44.

23 The PIOPED Investigators. Value of the ventilation perfusion scan in acute pulmonary embolism. Results of the prospective investigation of pulmonary embolism diagnosis (PIOPED). *JAMA* 1990; **263:** 2753–59.

24 Raskob GE, Hirsh J. Controversies in timing of the first dose of anticoagulant prophylaxis against venous thromboembolism after major orthopedic surgery. *Chest* 2003; **124:** 379S–85S.

25 Kelly J, Rudd A, Lewis RR, Coshall C, Moody A, Hunt BJ. Venous thromboembolism after acute ischemic stroke: a prospective study using magnetic resonance direct thrombus imaging. *Stroke* 2004; **35:** 2320–25.

26 Yalamanchili K, Sukhija R, Sinha N, et al. Efficacy of unfractionated heparin for thromboembolism prophylaxis in medical patients. *Am J Ther* 2005; **12:** 293–99.

27 Mismetti P, Laporte-Simitsidis S, Tardy B, et al. Prevention of venous thromboembolism in internal medicine with unfractionated or low-molecular-weight heparins: a meta-analysis of randomised clinical trials. *Thromb Haemost* 2000; **83:** 14–9.

28 Alikhan R, Cohen AT. A safety analysis of thromboprophylaxis in acute medical illness. *Thromb Haemost* 2003; **89:** 590–91.

29 Hull RD, Marder VJ, Mah AF, Biel RK, Brant RF. Quantitative assessment of thrombus burden predicts the outcome of treatment for venous thrombosis: a systematic review. *Am J Med* 2005; **118:** 456–64.

Uttar Pradesh—where over 80% of all type 1 cases of poliomyelitis in India in 2006 occurred—and Bihar. Frequent rounds of vaccination with mOPV1 have been interspersed with use of trivalent vaccine to maintain immunity to type 3 poliovirus. In the few districts with continued reporting of type 3 poliomyelitis, monovalent vaccine against type 3 (mOPV3) has also been used in up to two immunisation rounds.

We extracted data for cases of type 1 poliomyelitis and control individuals from the database of the National Polio Surveillance Project, which detects and investigates cases of acute flaccid paralysis in children aged less than 15 years in India. The National Polio Surveillance Project is an active surveillance system that receives reports from over 10 000 health-care institutions and 15 000 health-care practitioners.[13] All cases of acute flaccid paralysis undergo standard clinical, epidemiological, and laboratory investigations, including the collection of two stool samples to test for wild poliovirus. Data were extracted for patients in whom paralysis developed between January 1, 1997, and December 31, 2006. Laboratory confirmation of suspected cases of poliomyelitis was not routinely done before this time. Cases of acute flaccid paralysis without information on vaccine doses received or that did not have two adequate stool samples and had residual paralysis compatible with poliomyelitis were excluded from the analysis.

Institutional ethics approval was not sought since this is not a prospective intervention study. The paper reports an analysis of a National Surveillance database recording use of standard vaccines licensed by the National Regulatory Authority of the Government of India for use in India. The database is anonymised and free of personally identifiable information.

A case of type 1 poliomyelitis was defined as any case of acute flaccid paralysis with virological confirmation of type 1 wild poliovirus. Virological confirmation was done by the national laboratory network supported by the National Polio Surveillance Project. We estimated the sensitivity of laboratory testing for type 1 poliovirus from the consistency in results across the two stool samples collected from each case of acute flaccid paralysis.[14] The tests are assumed to be 100% specific since virus is grown in culture and all positive samples are sequenced in the VP1 region of the viral genome to allow differentiation of genotype and to identify any identical sequences that would indicate potential cross-contamination of samples.

Cases of acute flaccid paralysis from which wild poliovirus was not isolated from stool samples were defined as non-polio acute flaccid paralysis and could have been caused by a wide range of conditions including Guillain-Barré syndrome, trauma, and infection with other enteroviruses.[15] Control individuals were selected from these cases of non-polio acute flaccid paralysis and were matched to each case of poliomyelitis by district, age of onset of paralysis (to within 1 month), and date of onset of paralysis (to within 3 months). Matching criteria were chosen to reduce differences in exposure to wild poliovirus between cases and controls to a minimum, and are consistent with criteria used previously to estimate the efficacy of the trivalent vaccine.[10] We estimated the probability that a case of non-polio acute flaccid paralysis was actually infected with type 1 poliovirus (ie, the risk of misclassification) from the sensitivity and specificity of laboratory testing and the prevalence of type 1 poliovirus among all reported cases of acute flaccid paralysis.[14]

The number of doses of oral poliovirus vaccine reported by the parent to have been received by each case and control was extracted from the case investigation data. Individuals who recorded dose information were masked to the polio status of the child, which only became available after virological testing of the stool samples. These data do not differentiate between doses of oral poliovirus vaccine received through routine immunisation services, which use only trivalent vaccine, and supplementary immunisation activities, which use trivalent or monovalent vaccine. We therefore estimated the efficacy of mOPV1 under the assumptions of either 0% or 100% coverage by routine services. In the first case, we assumed that none of the total reported doses of vaccine were received through routine services. In the second case, the first three doses reported by cases and controls were assumed to have been trivalent vaccine received through routine services. The number of doses of monovalent and trivalent vaccine received by each case and control through supplementary immunisation activities was determined from their exposure to activities with different vaccine types based on their district of residence, date of birth, and date of onset of paralysis. For example, a child born on November 22, 2004, in Moradabad district in Uttar Pradesh, with date of onset of paralysis of November 12, 2005, would have been exposed to seven rounds of supplementary immunisation, four of which were with mOPV1 and the rest with trivalent vaccine. To estimate the number of doses of oral poliovirus vaccine of a particular type received by a child with acute flaccid paralysis, we multiplied the number of doses reported to have been received by the child by the fraction of supplementary immunisation activities that used vaccine of that type.

Statistical analysis

Vaccine efficacy was calculated by comparing the number of doses received by cases with that of matched controls by use of conditional logistic regression.[16] The odds of infection with paralytic poliovirus in India shows a log-linear relationship with the number of doses of trivalent vaccine received.[10] This finding is consistent with the mechanism of action of oral poliovirus vaccine, which shows an all-or-nothing response to vaccination in terms of protection against paralytic disease, with a **probability** of protection per dose that is independent of the number

	Cases of poliomyelitis	Matched cases of poliomyelitis
Age (years)		
<1	1820 (37%)	851 (41%)
1–2	2471 (50%)	1051 (51%)
3–4	458 (9%)	141 (7%)
5+	217 (4%)	33 (2%)
Location		
Uttar Pradesh	2973 (60%)	1499 (72%)
Bihar	439 (9%)	204 (10%)
Rest of India	1554 (31%)	373 (18%)
Period		
1997–2001	2540 (51%)	816 (39%)
2002–2006	2426 (49%)	1260 (61%)
Exposed to mOPV1, assuming		
(a) no routine tOPV	534 (11%)	451 (22%)
(b) first three doses routine tOPV	479 (10%)	405 (20%)
Total	4966 (100%)	2076 (100%)

Data are n (%). mOPV1=monovalent oral type 1 poliovirus vaccine. tOPV=trivalent oral poliovirus vaccine.

Table 1: **Characteristics of matched cases of type 1 poliomyelitis and all reported cases of type 1 poliomyelitis, 1997–2006**

of earlier doses.[17,18] We therefore estimated the log-odds of a paralytic infection with type 1 poliovirus as a linear function of the number of doses of vaccine of different types:

$$\ln(\text{odds}) = \beta_m x_m + \beta_t x_t + E$$

See Online for webappendix

where $(1-e^{\beta_m})$ is the per-dose protective efficacy of mOPV1 against type 1 paralytic poliovirus, $(1-e^{\beta_t})$is the per-dose protective efficacy of the trivalent vaccine against type 1 poliovirus, and x_m and x_t are the number of doses of mOPV1 and trivalent vaccine received, respectively. Each matched case-control pair has a particular level of exposure to wild poliovirus, E, which is unknown and can be eliminated from the analysis by maximising the conditional likelihood.[16] We estimated vaccine efficacy separately for the states of Uttar Pradesh and Bihar, and for the rest of India, by including an interaction term, since the efficacy of trivalent vaccine in these two northern states has been shown to be lower than in the rest of India.[10] We also examined the possibility of interference between mOPV1 and doses of trivalent vaccine by testing for an interaction.

To examine the hypothesis of a constant efficacy per dose for mOPV1, we also treated the estimated number of doses received as a categorical variable, and this unconstrained model was compared with the model with a constant per dose efficacy by use of the likelihood ratio statistic. Potential differences in mOPV1 efficacy by age were also examined by the inclusion of an interaction term for the age at onset of paralysis by 6-month age-groups. We tested the robustness of the process used to assign the vaccine type of each reported dose by examining the estimated efficacy of oral poliovirus vaccine irrespective of vaccine type before and after the introduction of monovalent vaccine in 2005.

The overall effectiveness of mOPV1 in Uttar Pradesh was assessed by calculating the proportion of children who were protected by vaccination against type 1 paralytic poliovirus, by 3-month age-groups, in the last quarter of 2004 (ie, just before the introduction of mOPV1) and the last quarter of 2006. This was estimated from the number doses of mOPV1 and trivalent vaccine received by children with non-polio acute flaccid paralysis, who are assumed to have the same level of vaccine coverage as other children from the same age-group and location, and the estimated efficacy for each of these vaccines (see webappendix for further details). A comparison was made with the estimated proportion of children protected in the last quarter of 2004 in the rest of India, where wild poliovirus transmission had been interrupted for the previous 2 years and continued immunisation had maintained the reproductive number below one, the threshold for persistence.[10] Immunity among 0–23-month-old children in the rest of India at this time is therefore indicative of exposure to vaccine virus alone, not wild poliovirus. The implications of mOPV1 for post-eradication risk management were assessed by calculating the number of doses of mOPV1 or of trivalent vaccine required to achieve a level of protection comparable with that which interrupted wild poliovirus transmission and maintained polio-free status in the rest of India.

All statistical analyses were implemented with the statistical programming language **R.**

	Vaccine	Location	Vaccine efficacy
	Trivalent	Rest of India	23% (17–29)
		Bihar	19% (8–29)
		Uttar Pradesh	11% (7–14)
No routine tOPV	Monovalent	Rest of India	36% (0–72)
		Bihar	18% (0–43)
		Uttar Pradesh	30% (19–39)*
First three doses routine tOPV	Monovalent	Rest of India	42% (0–71)
		Bihar	19% (0–47)
		Uttar Pradesh	31% (20–41)†

Data are efficacy (95% CI). tOPV=trivalent oral poliovirus vaccine. *Significantly better than trivalent vaccine in Uttar Pradesh, p=0·0007. †Significantly better than trivalent vaccine in Uttar Pradesh, p=0·0004.

Table 2: **Estimated per dose protective efficacy of mOPV1 and trivalent vaccine against paralysis by type 1 poliovirus in India**

Role of the funding source

The funding source had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. All authors had full access to all the data. NCG had final responsibility to submit for publication.

Results

122 173 cases of acute flaccid paralysis were identified. Of these, 2580 did not have two adequate stool samples and had residual paralysis compatible with poliomyelitis and were thus excluded from the analysis; a further 5773 cases did not report the number of vaccine doses received and were also excluded. 4966 cases of type 1 poliomyelitis had complete dose information for the entire study period; of these, 2076 were matched with suitable controls (table 1). The age distribution of matched cases was much the same as that for all reported cases of poliomyelitis. There was a greater probability of finding a matched control in Uttar Pradesh in recent years because there were more reported cases of non-polio acute flaccid paralysis in this region compared with other parts of India; in 2006, 388 (86%) cases of type 1 poliomyelitis reported from Uttar Pradesh were matched with a control. Between 438 and 460 matched controls were exposed to at least one supplementary immunisation activity with mOPV1, depending on the assumed routine coverage with trivalent vaccine.

We estimate that the protective efficacy of mOPV1 in Uttar Pradesh is 30% (95% CI 19–39) per dose under the assumption of no routine coverage with trivalent vaccine and 31% (20–41) under the assumption of 100% coverage of routine programmes with up to three doses of trivalent vaccine (table 2). Both efficacy estimates are significantly higher than that for trivalent vaccine against type 1 poliovirus in Uttar Pradesh, which we estimated to be 11% per dose, irrespective of the assumption about routine coverage ($p=0\cdot0007$ and $0\cdot0004$ for each assumption). The estimate of mOPV1 efficacy is largely independent of the assumption about routine coverage with trivalent vaccine. Therefore, our (conservative) point estimate of mOPV1 efficacy is 30% per dose, with a CI of 19–41%, which spans the intervals for our two estimates. In Bihar and the rest of India, there were insufficient cases of poliomyelitis in 2006 to allow us to estimate mOPV1 efficacy precisely (table 2). As expected, there was no significant interaction between doses of mOPV1 and of trivalent vaccine in protecting against paralytic type 1 poliovirus, since supplementary immunisation activities occured at least 4 weeks apart to avoid interference between vaccine virus doses ($p=0\cdot54$ and $p=0\cdot21$ for each assumption).

The estimated odds of infection with paralytic poliovirus was found to fall exponentially with increasing number of doses of mOPV1 or trivalent vaccine, consistent with the assumption of a constant vaccine efficacy per dose (webfigure 1). Furthermore, the model with a constant probability of providing protection per dose did not give a significantly worse fit than the unconstrained model with differing efficacy by number of vaccine doses previously received (likelihood ratio test $p=0\cdot9$). The estimated efficacy of mOPV1 was not dependent on age at onset of paralysis.

We estimated that the sensitivity of testing for type 1 poliovirus from cases of acute flaccid paralysis with two stool samples was 97%, which is consistent with previous estimates.[10,19] The prevalence of type 1 poliovirus among all cases of acute flaccid paralysis was estimated to be 4·7% and the probability of misclassifying a child paralysed by type 1 poliovirus as a non-polio acute flaccid paralysis control to be 0·0017.

Figure 1 shows the effect of mOPV1 on the proportion of children protected by vaccination against type 1 paralytic poliovirus for Uttar Pradesh, assuming 0% routine coverage with trivalent vaccine. Similar results were found when we assumed that there was 100% routine coverage with trivalent vaccine (webfigure 2). The number of doses of oral poliovirus vaccine received by children aged 0–23 months, as estimated from data

See Online for webfigures 1 and 2

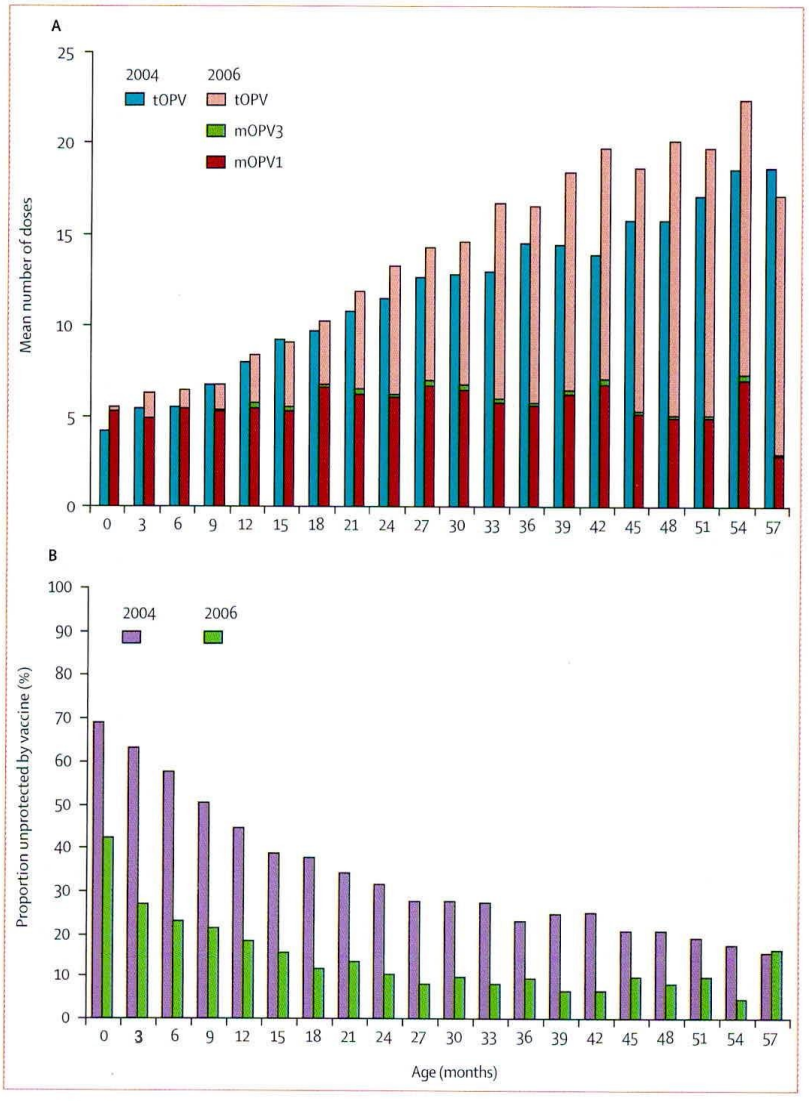


Figure 1: **The effect of monovalent vaccine on population immunity among children in Uttar Pradesh**
Calculations assume that all doses were received through supplementary immunisation campaigns. (A) The mean number of doses of each type of oral poliovirus vaccine received by children in Uttar Pradesh by 3-month age-groups, comparing the last quarter of 2004 with 2006. (B) The proportion of children in Uttar Pradesh who remained unprotected by oral vaccine against type 1 paralytic poliovirus in the last quarter of 2004 and 2006, based on the estimated coverage and efficacy of monovalent and trivalent vaccines. mOPV1=monovalent oral type 1 poliovirus vaccine. mOPV3=monovalent oral type 3 poliovirus vaccine. tOPV=trivalent oral poliovirus vaccine.

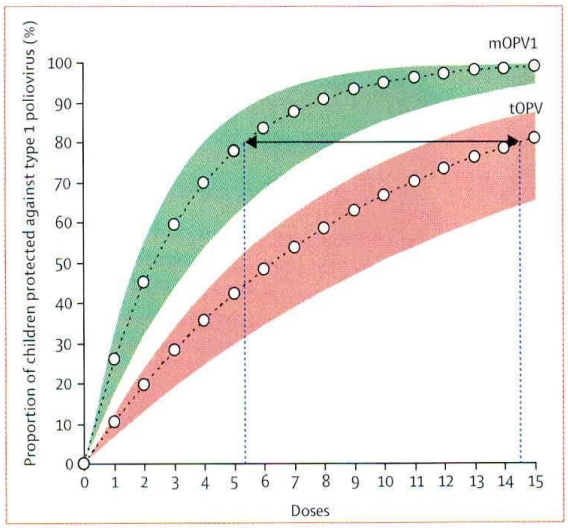


Figure 2: **Proportion of children protected against type 1 paralytic poliovirus**
Based on vaccine efficacy estimates for Uttar Pradesh. The shaded areas represent 95% CI for the per dose efficacy estimates. mOPV1=monovalent oral type 1 poliovirus vaccine. tOPV=trivalent oral poliovirus vaccine.

for cases of non-polio acute flaccid paralysis, shows a marginal improvement, from an average of seven doses in the last quarter of 2004 to eight doses for the same period in 2006 (figure 1). However, there was a substantial improvement in population immunity between the two periods, since in 2006 about half of the doses received in this age-group were mOPV1 (45–69%, depending on assumed coverage of routine services; figure 1 and webfigure 2). Consequently, in the last quarter of 2004, 59% of children aged 0–23 months in Uttar Pradesh were protected against type 1 poliovirus, compared with 76–82% of children in this age-group in the last quarter of 2006. This finding is comparable with an estimated 81% of children aged 0–23 months protected against type 1 poliovirus in the rest of India (excluding Bihar) during the last quarter of 2004.

The overall protective efficacy of vaccine given to children in Uttar Pradesh, irrespective of the inferred vaccine type, was estimated to be 25% (95% CI 17–31) per dose in 2006, compared with 9% (5–14) in the 5 years preceding the distribution of monovalent vaccine ($p=0\cdot0002$). This increase in overall vaccine efficacy following the introduction of mOPV1 supports the notion that this vaccine has greater efficacy than does trivalent vaccine, irrespective of the process used to classify the type of vaccine for each reported dose.

The greater efficacy of mOPV1 leads to much more rapid protection of children than with trivalent vaccine in Uttar Pradesh (figure 2). Each child would need to receive about five doses of mOPV1 to achieve an estimated **78%** (range 61–87) level of vaccine-generated immunity, which is comparable with that needed to interrupt wild poliovirus transmission in the rest of India. By contrast, 14 doses of trivalent vaccine would be needed to reach such a level of protection.

Discussion

Our results show that, in the state of Uttar Pradesh, the monovalent vaccine is about three times more likely to result in a protective immune response against type 1 paralytic poliomyelitis than is the trivalent vaccine, irrespective of the assumption about routine immunisation. This increased efficacy is probably caused by the absence of interference between the three Sabin vaccine strains.[20] Even balanced formulations of trivalent poliovirus vaccines tend to result in preferential infection and seroconversion to type 2 virus, especially in developing countries, most likely explaining the global eradication of wild type 2 poliovirus in 1999.

The relative efficacy of mOPV1 is somewhat better than expected from seroconversion studies after vaccine administration, in which a relative rate of seroconversion per dose of 2–2·5 was found.[5] However, an estimated per dose efficacy of 30% is substantially lower than an overall seroconversion rate of 72% (range 53–89) observed in four small studies from developing countries,[5] which is probably the result of the higher prevalence of diarrhoea and other infections in Uttar Pradesh. Such infections can severely compromise the efficacy of live-attenuated oral poliovirus vaccine, as has been shown for the trivalent vaccine.[11,12] Vaccine quality is unlikely to be a problem, since temperature-sensitive vaccine vial monitors have been used in India since 1998, and routine testing of samples of vaccine vials from the field have found consistently high vaccine potency ($>10^6$ $CCID_{50}$ per dose). We were unable to generate precise estimates of the efficacy of mOPV1 outside Uttar Pradesh; nevertheless, efficacy is probably higher in the rest of India because of the lower prevalence of diarrhoea and other infections.

Although the estimated per dose efficacy of mOPV1 is below that observed in other studies, its efficacy was three times greater than that of the trivalent vaccine in the same setting, which has important implications for interrupting the remaining chains of wild poliovirus transmission in India as well as managing post-eradication risks. Most importantly, our estimate that 76–82% of children aged 0–23 months were protected by vaccine against type 1 paralytic poliovirus in Uttar Pradesh in the last quarter of 2006 due to the use of mOPV1 in over half the supplementary immunisation activities compares favourably with the estimated 81% achieved in the rest of India (excluding Bihar) at the end of 2004 when endemic transmission of type 1 wild poliovirus had been stopped for 2 years and the reproductive number maintained below the threshold for persistence.[10] In both cases, actual population immunity will be somewhat higher than these estimates of primary vaccine-derived immunity, due to natural exposure to wild poliovirus, secondary vaccine virus transmission, and the presence of maternal antibodies that protect children in the first few months of life.

Although a proportion of the children who seroconvert after immunisation with oral poliovirus vaccine can still

become infected with poliovirus, the observation of a herd effect sufficient to interrupt transmission in the rest of India is consistent with studies that show that the duration and titre of viral excretion in children who become infected after immunisation are substantially reduced compared with unimmunised children.[21–23] In Uttar Pradesh, the proportion of children that need to be protected to interrupt transmission could be higher than in the rest of India, since higher population densities and poorer sanitation probably result in a greater transmission potential of wild poliovirus.

The higher per dose efficacy of mOPV1 compared with trivalent vaccine would facilitate a much more rapid increase in population immunity during an outbreak response in the post-eradication era. In the setting of Uttar Pradesh, five doses of mOPV1 would be needed to protect about 80% of children against type 1 poliomyelitis (figure 2). A comparable level of protection with trivalent vaccine would require 14 doses. This lends support to the idea of the stockpiling monovalent vaccines for managing the risks associated with polioviruses in the post-eradication era, as proposed by the Advisory Committee on Polio Eradication.[6]

Several factors could affect the precision of our estimate of the field efficacy of mOPV1. The number of doses of vaccine of different types recorded for each case of acute flaccid paralysis relies on accurate reporting of doses received and correct classification of the vaccine dose administered. Any misreporting that might have occurred is unlikely to have affected our estimate of vaccine efficacy, since more detailed follow-up of a subset of cases of poliomyelitis in 2005 found no tendency towards under-reporting or over-reporting of doses. Misclassification of vaccine doses received by individuals with acute flaccid paralysis will lead to an underestimate of the true mOPV1 efficacy, since trivalent doses could erroneously be recorded as mOPV1. Although such a misclassification could have some effect on our estimate of mOPV1 efficacy, the proportion of children missed by each supplementary immunisation activity is small (<5%) and exposure to different types of such activities is strongly correlated with the number of doses reported by individuals with acute flaccid paralysis, suggesting misclassification—and misreporting—is limited (webfigure 3). That mOPV1 is more effective than trivalent vaccine is lent strong support by the increased estimated efficacy of oral poliovirus vaccine in 2006, irrespective of vaccine type, compared with the 5 years before its introduction. Before the introduction of mOPV1, estimated vaccine efficacy based on data gathered since 1997 did not change over time.[10]

Children with non-polio acute flaccid paralysis are a suitable control group for the analysis since they come from the same communities as reported cases of poliomyelitis. The estimate of vaccine efficacy would be biased if these children were in fact paralysed due to infection with type 1 poliovirus. However, the estimated probability of misclassification is very low; indeed, just three cases of type 1 poliomyelitis would be expected to be misclassified as controls over the entire period of the analysis and less than one during 2005–06, when mOPV1 was in use. Although just under half the cases of type 1 poliomyelitis could be matched, the tendency to select recent cases from Uttar Pradesh in the analysis of efficacy does not introduce bias, since the analysis is stratified by location and there has been no temporal change in the efficacy of the trivalent vaccine.[10] Furthermore, the estimate of mOPV1 efficacy is largely based on matched case-controls from the outbreak in 2006 centred on Uttar Pradesh, when 86% of cases were matched with controls. Indeed the estimated efficacy of mOPV1 remains at 30% per dose (range 19–41) when based on these cases alone.

Further studies are required to refine our understanding of the field efficacy of mOPV1, and also monovalent vaccine against type 3 poliovirus, and their role in interrupting the final chains of wild poliovirus transmission worldwide and managing post-eradication risks. Seroconversion studies after administration of trivalent vaccine and mOPV1 should be completed in India and elsewhere to assess the relative immunogenicity of these vaccines in different settings. However, most important to the elimination of poliovirus from the four remaining endemic areas in the world is achieving and sustaining high coverage with oral poliovirus vaccine of the appropriate type in all geographical areas and among all population subgroups. The 2006 outbreak of type 1 poliomyelitis in India, despite the introduction of a substantially more efficacious vaccine since mid-2005, serves as stark evidence of the need for high coverage with multiple doses of vaccine as early as possible in life in these areas. Achieving such coverage will require sustained dialogue with local communities and strong political commitment. If these conditions can be met, the prospects are now very good for the elimination of wild poliovirus transmission worldwide.

Contributors

NCG and RBA conceived the analysis and wrote the final manuscript, NCG applied the analysis, JW coordinated surveillance of acute flaccid paralysis, SD supported the analysis, SB supervised data collection, JMD did the laboratory testing of cases, and DLH and RWS contributed to the concept and review of the paper. All authors reviewed the analysis and contributed to the writing of the paper.

Conflict of interest statement

We declare that we have no conflict of interest.

See **Online** for webfigure 3

Acknowledgments

This work was supported by a Royal Society University Research Fellowship to NCG. We thank C Fraser for discussion and anonymous reviewers for suggestions to improve the manuscript.

References

1 World Health Organization. Conclusions and recommendations of the Ad Hoc Advisory Committee on Poliomyelitis Eradication, Geneva, 21–22 September 2004. *Wkly Epidemiol Rec* 2004; **79:** 401–08.

2 World Health Organization. Progress towards global eradication of poliomyelitis, 2003 and January–April 2004. *Wkly Epidemiol Rec* 2004; **79:** 229–36.

3 World Health Organization. Progress towards poliomyelitis eradication in Egypt, January 2003 to July 2004. *Wkly Epidemiol Rec* 2004; **79:** 316–19.

4 World Health Organization. Progress towards poliomyelitis eradication in India, 2003. *Wkly Epidemiol Rec* 2004; **79:** 121–25.

5 Caceres VM, Sutter RW. Sabin monovalent oral polio vaccines: review of past experiences and their potential use after polio eradication. *Clin Infect Dis* 2001; **33:** 531–41.

6 World Health Organization. Conclusions and recommendations of the Advisory Committee on Poliomyelitis Eradication, Geneva, 11–12 October 2005. *Wkly Epidemiol Rec* 2005; **80:** 409–16.

7 Graf H. Manufacturing and supply of monovalent oral polio vaccines. *Biologicals* 2006; **34:** 141–44.

8 Aylward RB, Sutter RW, Cochi SL, Thompson KM, Jafari H, Heymann D. Risk management in a polio-free world. *Risk Anal* 2006; **26:** 1441–48.

9 Aylward RB, Sutter RW, Heymann DL. OPV cessation - the final step to a "polio-free" world. *Science* 2005; **310:** 625–26.

10 Grassly NC, Fraser C, Wenger J, et al. New strategies for the elimination of polio from India. *Science* 2006; **314:** 1150–53.

11 The World Health Organization Collaborative Study Group on Oral Poliovirus Vaccine. Factors affecting the immunogenicity of oral poliovirus vaccine—a prospective evaluation in Brazil and the Gambia. *J Infect Dis* 1995; **171:** 1097–106.

12 Posey DL, Linkins RW, Oliveria MJC, Monteiro D, Patriarca PA. The effect of diarrhea on oral poliovirus vaccine failure in Brazil. *J Infect Dis* 1997; **175:** S258–63.

13 Banerjee K, Hlady WG, Andrus JK, Sarkar S, Fitzsimmons J, Abeykoon P. Poliomyelitis surveillance: the model used in India for polio eradication. *Bull World Health Organ* 2000; **78:** 321–29.

14 Gary HE Jr, Sanders R, Pallansch MA. A theoretical framework for evaluating the sensitivity of surveillance for detecting wild poliovirus: I. Factors affecting detection sensitivity in a person with acute flaccid paralysis. *J Infect Dis* 1997; **175** (suppl 1): S135–40.

15 Marx A, Glass JD, Sutter RW. Differential diagnosis of acute flaccid paralysis and its role in poliomyelitis surveillance. *Epidemiol Rev* 2000; **22:** 298–316.

16 Clayton D, Hills M. Statistical models in epidemiology. Oxford: Oxford University Press, 1993.

17 Sutter RW, Kew OM, Cochi SL. Poliovirus vaccine—live. In: Plotkin SA, Orenstein WA, eds. Vaccines, 4th edn. Philadelphia, PA, USA: Saunders, 2004: 651–705.

18 Halsey N, Galazka A. The efficacy of DPT and oral poliomyelitis immunization schedules initiated from birth to 12 weeks of age. *Bull World Health Organ* 1985; **63:** 1151–69.

19 Kohler KA, Deshpande JM, Gary HE, Banerjee K, Zuber PLF, Hlady WG. Contribution of second stool specimen to increased sensitivity of poliovirus detection in India, 1998–2000. *Epidemiol Infect* 2003; **131:** 711–18.

20 Patriarca PA, Wright PF, John TJ. Factors affecting the immunogenicity of oral poliovirus vaccine in developing countries: Review. *Rev Infect Dis* 1991; **13:** 926–39.

21 Henry JL, Jaikaran ES, Davies JR, et al. A study of poliovaccination in infancy: excretion following challenge with live virus by children given killed or living poliovaccine. *J Hyg (Lond)* 1966; **64:** 105–20.

22 Onorato IM, Modlin JF, McBean AM, Thoms ML, Losonsky GA, Bernier RH. Mucosal immunity induced by enhanced-potency inactivated and oral polio vaccines. *J Infect Dis* 1991; **163:** 1–6.

23 Ghendon YZ, Sanakoyeva II. Comparison of the resistance of the intestinal tract to poliomyelitis virus (Sabin's strains) in persons after naturally and experimentally acquired immunity. *Acta Virol* 1961; **5: 265–73.**

On 21 April 2007, a leading medical journal - The Lancet - published a new study by Kim Thompson et al from Harvard University, demonstrating that effective control of polio (eg maintaining low numbers of polio cases) would cost more in the long-term - both in human suffering and dollars - than finishing eradication.

Below are answers to frequently asked questions relating to the study.

What are the study's main findings?

- Concerns about the high perceived costs of eradicating the relatively low number of polio cases worldwide have led to recent suggestions that it is time to shift from a goal of eradication to control-abandoning eradication and allowing wild polioviruses to continue to circulate-which proponents of control believe can sustain the low number of cases. This paper urges explicit consideration of the health and financial trade-offs associated with this choice.
- Comparing the numbers of expected cases and costs for 20 years into the future for a range of eradication and control options, the study finds that eradication is the best solution. As long as it is technically achievable, eradication offers both lower cumulative costs and cases than control in the long-term, even with the costs of achieving eradication exceeding several billion dollars more.
- The results suggest that control means a future with high costs and low cases or with low costs and high cases. Low costs and low cases is only an option if we continue to pay high costs in the short-term until we eradicate.
- Results from a dynamic model of endemic wild poliovirus transmission in the populous Northern India states of Uttar Pradesh and Bihar show that eliminating the virus requires that we increase the immunization intensity.
- Permanently reducing vaccination intensity even by a small percentage will lead to a significant resurgence of polio incidence and thousands of annual cases expected just in Uttar Pradesh and Bihar.
- This study demonstrates that acting based on concerns of incurring high costs to prevent few polio cases will eventually lead to more polio cases and much higher cumulative costs compared to eradication followed by cessation of vaccination. A wavering commitment to eradication is not a good option.

What are the study's main recommendations?

- We should require stakeholders in the debate about whether to give up or pursue the current option to eradicate polio to make their

assumptions about costs and cases of specific options explicit and transparent.

- We need to take a long-term perspective with respect to decisions about global polio eradication. Failing to do so will not only put children in developing countries at a higher risk of getting polio, but in the long term will also hurt other public efforts in those countries.
- Discussions about opportunity costs should consider the opportunity costs that we will incur if we do not eradicate polio, which will include real children paralyzed by the disease (predominantly in low-income countries that already suffer from large disease burdens) and real resources that we will continue to spend on polio control in perpetuity that cannot be used for other public health interventions.

What do the cost-effectiveness ratios mean in this paper?

- This paper sought to expose the weakness of thinking in terms of high costs aimed at a disease with a now very low global number of reported cases, which is the way that some non-economists appear to be looking at the current situation for polio. To demonstrate this, this paper modeled what would happen if we based decisions on a naïve understanding of cost-effectiveness ratios formulated as costs per case. The demonstrative example in the paper shows that basing decisions on a concern about high costs per case would result in a failure to complete eradication, and ultimately yield higher costs and more polio cases due to a wavering commitment. This problem is one reason why economists use costs per case prevented for cost-effectiveness ratios.
- In the analysis for all of the low-income group countries, the study notably does not present incremental cost-effectiveness ratios. However, Figure 5 shows the costs and cases of the various eradication and control options from which these could be derived. The costs of achieving eradication are unknown and as stated in the paper they are not included. Instead, the study focuses on estimating the amount that we should be willing to spend to achieve eradication. The results of the analysis of the amount that we should be willing to pay to eradicate results can be correctly interpreted as showing that from an incremental cost-effectiveness perspective eradication dominates control as long as the costs of eradication are less than a minimum of $3 billion ($2 billion if we completely ignore treatment costs and outcomes in middle-income countries). In addition, since all of the eradication scenarios yield fewer cases than the control options (except for the bad option of OPV without supplemental immunization activities after eradication vs. high control options), we would obtain negative denominators and thus negative and non-standard incremental cost-effectiveness ratios (implying that we would save money to suffer worse health outcomes). (Note: Another paper that provides estimates of incremental cost-effectiveness ratios and incremental net benefits for future polio risk management is currently submitted and economists interested in reviewing that paper should contact Professor Thompson to obtain a review copy. The embargo **policies**

of the journal to which that paper is submitted preclude posting that manuscript and its detailed technical appendix or any public distribution prior to its publication.)

How much will polio eradication actually cost?

- We do not know the costs needed to finish eradication or the time required, although with very few areas remaining endemic so long as we sustain the commitment eradication appears close.

Is global polio eradication feasible?

- One of the three wild poliovirus serotypes (type 2) was eradicated globally in 1999. The GPEI has demonstrated the ability to interrupt wild poliovirus in some of the most challenging regions, including areas with high population density, poor sanitation, almost no public health infrastructure, and civil or military conflict.
- This paper assumes that "eradication is achievable provided that we are willing to commit the necessary resources."

What is immunization intensity?

- Immunization intensity is an indication of the level of effort aimed at increasing population immunity. We define immunization intensity specifically as the fraction of susceptible people who become immune because of exposure to oral vaccine viruses per year (i.e., from successful routine or supplemental oral poliovirus vaccination, or secondary exposure to oral poliovirus vaccine).

Why are the costs of control in the endemic areas so high for every modeled control option?

- The study assumes that the control policies would involve sufficient resources to effectively maintain the current incidence of approximately 1,300 paralytic polio cases per year in endemic areas. If not, we will likely see a rapid expansion of the endemic areas and more frequent importation outbreaks into countries that are now free of wild poliovirus transmission.

NOW, MORE THAN EVER: STOP POLIO FOREVER.

World Health Organization · CDC · unicef

Partners in the Global Polio Eradication Initiative

Global Polio Eradication Initiative

The Lancet: publication of monovalent oral polio vaccine efficacy study

Interpretation and significance

Synopsis:
On 12 April 2007, a leading medical journal, *the Lancet*, published the results of a new study[1], showing increased efficacy of monovalent oral polio vaccine type 1 (mOPV1) over the traditionally-used trivalent OPV against paralytic polio due to type 1 poliovirus. The results of this study have substantial implications to the global polio eradication effort, and emphasizes the technical feasibility of rapidly finishing polio once and for all.

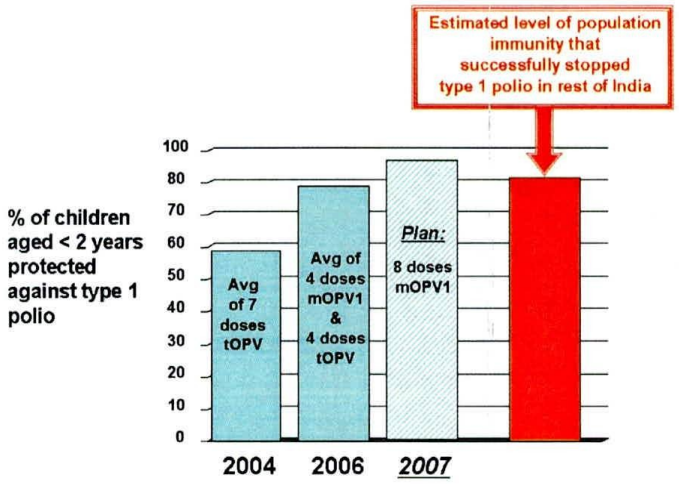
New Lancet publication: Fast Facts
- ✓ mOPV1 three times as effective as trivalent OPV against type 1 polio
- ✓ Wide-scale use of mOPV1 can raise population immunity to levels necessary to stop indigenous type 1 polio in India
- ✓ *Key to success: reaching all children multiple times with mOPV1!*

Study results:
The study confirms the increased efficacy of mOPV1 over trivalent OPV against type 1 polio. In a field study in Uttar Pradesh, India (one of only two remaining endemic states in India), mOPV1 was shown to be three times more effective than trivalent OPV at protecting children against type 1 polio. The study estimates that 30% of children in this key area of persistent wild poliovirus transmission are fully protected against type 1 polio after a single dose of mOPV1 compared to only 11% of children after a single dose of trivalent OPV.

Interpretation and significance:
Uttar Pradesh is arguably one of the most difficult places on earth to eradicate polio, due to a number of programmatic and environmental challenges, including low levels of routine immunization services, inadequate sanitation infrastructure, high population density and large birth cohorts. Oral polio vaccines have been shown to be less effective in areas such as Uttar Pradesh, due to high prevalence of diarrhoeal disease and other intestinal infections thus facilitating intense transmission of wild poliovirus. Due to the specific environmental challenges and compromised efficacy of trivalent OPV in Uttar Pradesh, poliovirus transmission has continued to persist, despite high vaccination coverage with trivalent OPV.

[1] Grassly NC et al, *Protective efficacy of a monovalent oral type 1 poliovirus vaccine: a case-control study*, The Lancet, 12 April 2007.

Vaccination coverage versus population immunity:
Due to the challenging conditions in Uttar Pradesh, higher levels of population immunity are required to interrupt polio transmission than were required in the rest of India. It is estimated that on average 7 doses of trivalent OPV among children aged 0-23 months in other parts of India succeeded in protecting at least 80% against paralysis and interrupted poliovirus transmission, compared to only 59% protected in Uttar Pradesh at the end of 2004.



mOPV1 use: markedly increases population immunity with same number of doses
The study shows that much higher levels of population immunity can be achieved using mOPV1 with the same vaccination coverage compared to use of trivalent OPV, resulting in a dramatically compounded impact on population immunity levels. It is estimated that on average 4 doses of mOPV1 and 4 doses of trivalent OPV resulted in 79-82% of children being protected at the end of 2006, compared with only 59% of children protected by 7 doses of trivalent OPV alone. In 2007, an aggressive new tailored approach to eradication was launched in the country aiming to administer 8 doses of mOPV1 to every child aged 0-23 months in the remaining endemic areas of the country. Based on the study results, this plan would lead to a level of population immunity *greater than* that achieved in the other areas of India that have already eradicated the disease. This is extremely significant, as it suggests that repeated and large-scale administration of mOPV1 could now rapidly interrupt the remaining chains of type 1 polio transmission for the first time ever in these areas of India.

Additional information:
Of further significance is the fact that in most areas of western Uttar Pradesh, including in the five traditionally highest-risk districts centred around Moradabad, no new cases of type 1 polio have occurred since October 2006. While it is too early to say if type 1 polio transmission has been successfully interrupted in these highest-risk districts of western Uttar Pradesh, it is clear that the levels of population immunity have been significantly increased in these areas in the latter half of 2006.

Key to rapid success in India is now to further increase the quality of large-scale polio immunization campaigns to reach every child with mOPV1, and sustain these levels until transmission has been successfully interrupted throughout the country. mOPV1 may prove to be one of the most important new tools in finishing the job of polio eradication, and protecting the global US$5 billion investment made in the Global Polio Eradication Initiative.