

ABSTRACT

Objectives. This study evaluated the impact of international coordination on polio eradication in Southeast Asia.

Methods. Active surveillance systems for acute flaccid paralysis were assessed. Analyses focused on surveillance proficiency and polio incidence.

Results. Ten countries coordinated activities. Importations occurred and were rapidly contained in China and Myanmar. Countries that have been free of indigenous polio transmission for at least 3 years include Sri Lanka, Indonesia, Myanmar, and Thailand. In the remaining endemic countries—India, Nepal, and Bangladesh—poliovirus transmission has been substantially reduced; however, these countries still harbor the world's largest polio reservoir.

Conclusions. Unprecedented international coordination in Southeast Asia resulted in dramatic progress in polio eradication and serves as a paradigm for control of other infectious diseases such as malaria and tuberculosis. (*Am J Public Health.* 2001;91:146–150)

A New Paradigm for International Disease Control: Lessons Learned From Polio Eradication in Southeast Asia

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Complete interruption of wild poliovirus transmission is the goal of the global polio eradication initiative.¹ High-quality surveillance of acute flaccid paralysis and wild poliovirus ultimately demonstrates whether the target has been achieved.² Such surveillance directs the allocation of resources to areas with ongoing virus transmission requiring more concentrated efforts, such as areas with heavy migration and large numbers of border crossings.³

Other strategies for polio eradication are (1) routine immunization with at least 3 doses of oral polio vaccine, (2) national immunization days on which every child younger than 5 years receives 2 extra doses of oral polio vaccine, and (3) extensive house-to-house immunization “mop-up” campaigns in the final stages.²

A major challenge to the success of polio eradication is reintroduction of wild poliovirus from the remaining endemic countries into polio-free countries and countries that are rapidly becoming polio free. Repeated importations of polio from Southeast Asia to industrialized countries demonstrate the critical importance of Southeast Asia to global disease control.^{4–9} International borders impose other operational impediments, but genomic sequencing data demonstrate shared reservoirs of wild poliovirus transmission that cross borders.

In this report, we focus on (1) international coordination in the area of polio eradication, (2) progress toward polio eradication in the 10 member states of the World Health Organization (WHO) Southeast Asia Region (total population: 1.2 billion), and (3) lessons learned for effective control of infectious disease transmission across international borders.

Methods

To evaluate lessons learned in international disease control through the polio eradication initiative, we undertook a review of the working papers, reports, and recommendations of the international technical oversight body for polio eradication in the WHO Southeast Asia Region, the Technical Consultative Group, and its partner coordinating body, the Interagency Coordinating Committee. The Interagency Coordinating Committee meets to assess how funds are being used and to review

resource requirements for the plan of action. The Technical Consultative Group and the Interagency Coordinating Committee coordinate activities between governments and assist partner agencies.

To evaluate progress toward polio eradication, we analyzed data from the Southeast Asia Region acute flaccid paralysis surveillance system. For the purposes of eradication, WHO recommends that every case of acute flaccid paralysis be reported and immediately investigated (i.e., within 48 hours of paralysis onset) and that 2 stool samples from each case subject be collected for analysis in a WHO-accredited laboratory.¹⁰ The results of clinical follow-up and virus isolation studies are used to classify acute flaccid paralysis cases as polio or nonpolio. Wild-virus-confirmed polio is defined as a case of polio associated with the isolation of wild poliovirus. With the exception of Sri Lanka (in 1993) and India (in 2000), all countries have reported both clinically confirmed and wild-virus-confirmed cases as polio.¹⁰

Surveillance sensitivity is demonstrated via the monitoring of standardized proficiency indicators: nonpolio acute flaccid paralysis reporting rate (target rate: more than 1 per 100 000 residents younger than 15 years) and stool collection (target rate: more than 80% of acute flaccid paralysis cases with 2 adequate stools collected fewer than 15 days after paralysis onset).

A unique case identification number is assigned to each case to link the epidemiologic and laboratory data. Data are reported on a weekly basis to the national immunization section and then to the WHO Southeast Asia Regional Office. Case investigation data and laboratory results are entered into a software program, Information for Action, developed for polio eradication by WHO and the Centers

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for Disease Control and Prevention (CDC). Epi Info 6.14 (CDC, Atlanta, Ga) was used in analyzing data.

Results

International Coordination of Polio Eradication Strategies

Since 1994, the Technical Consultative Group has met at least yearly to review progress, provide recommendations, and, when appropriate, revise strategies. In 1999, the group met twice to provide guidance on doubling polio immunization activities in India and Bangladesh to meet the eradication target by 2000. Given several issues—accurate epidemiologic profile of transmission, low vaccination coverage, large annual birth cohorts, and a high prevalence of densely populated communities with poor sanitary conditions—India decided, with guidance from the Technical Consultative Group, to make dramatic adjustments in its eradication strategies.^{11–13} In the winter of 1999–2000, India decided to conduct 4 rounds of national immunization days followed by 2 rounds of subnational immunization days statewide in 8 selected high-risk states in the northern part of the country. Bangladesh, another major polio reservoir and a country sharing a border with India, also needed to make major adjustments in its strategies consistent with India's.

In 1994, a core group of partners emerged to support polio eradication in Southeast Asia, including WHO, the United Nations Children's Fund (UNICEF), Rotary International, and the CDC. By 2000, 14 partners had been success-

fully recruited to assist governments in funding polio eradication activities. Many of these partners work in multiple countries of Southeast Asia, also providing assistance with international coordination of efforts.

In 1994, Thailand was the first Southeast Asian country to conduct national immunization days; by 1997, all 8 polio endemic or recently endemic countries of the region had conducted national immunization days. Because countries of Southeast Asia form an epidemiologic block with similar high-transmission months for poliovirus, the Technical Consultative Group recommended that these countries synchronize their national immunization days. In December 1997 and January 1998, Bangladesh, Bhutan, China, India, Myanmar, Nepal, Pakistan, and Thailand synchronized national immunization days, vaccinating nearly 248 million children, 38% of the world's population of children younger than 5 years (Table 1).

Since 1997, weekly surveillance data have been sent electronically from districts to the national level and the WHO regional office, providing a mechanism for health officials at all levels to receive a weekly overview of the polio situation for the region. Nepal sends its stool specimens to Bangkok's laboratory for culture; Myanmar sends stool specimens for intratypic differentiation to Bangkok. WHO publishes a weekly polio bulletin that serves to link and strengthen coordination of activities among all countries.

The Southeast Asia Regional Office coordinates and manages the polio network of 17 laboratories by providing technical assistance and essential reagents, transferring technologies such as genetic sequencing, and convening yearly meetings to address operational

constraints. The office also coordinates the accreditation of laboratories using 6 standardized performance indicators. By November 1999, of the 17 network laboratories conducting poliovirus isolation from stool specimens collected in acute flaccid paralysis cases, 14 were fully accredited by WHO. One (Jakarta) is being reviewed for accreditation, and 2 (Dhaka and Pyongyang) are being strengthened for review.

The response of WHO's global polio laboratory network to the finding of wild poliovirus type 1 in 1999 in China in a paralyzed boy aged 16 months was critical for determining the origin and coordinating responses in neighboring countries. China had last isolated indigenous wild poliovirus in 1994, and the identification of a wild poliovirus case in 1999 threatened to seriously compromise the polio-free status of China and WHO's Western Pacific Region. WHO coordinated the molecular epidemiologic investigation between the National Poliovirus Laboratory in Beijing, the CDC in the United States, and the Enterovirus Research Center in Mumbai. The evaluation showed that the virus strain found in China was closely related to poliovirus strains circulating in northern and central India during 1998 and 1999, suggesting an imported virus from that country.¹⁴

To further strengthen international coordination, the Southeast Asia Regional Office convened a meeting of health officials from Bangladesh, India, and Nepal in February 1999 to discuss mechanisms for immediate reporting of acute flaccid paralysis cases and control activities across borders. Countries recommended that the group be expanded to include other neighboring countries of Southeast Asia.

TABLE 1—Number of Reported Acute Flaccid Paralysis (AFP) Cases, Nonpolio AFP Rates, Confirmed Polio Cases, and Poliovirus Strains Detected, by Country: Southeast Asia Region, 1997 and 1999

Country	No. of Reported AFP Cases		Nonpolio AFP Rate		AFP Cases With Adequate Specimens, ^a %		No. of Confirmed Cases ^b (No. of Wild Virus Cases)		Wild Virus Detected ^c
	1997	1999	1997	1999	1997	1999	1997	1999	
Bangladesh	244	761	0.14	0.71	34	49	173 (5)	384 (28)	P1/P3
Bhutan	0	0	0.00	0.00	0	0	0 (0)	0 (0)	...
India	3 047	9 578	0.22	1.83	34	72	2 275 (702)	2 794 (1 126)	P1/P2/P3
Indonesia	801	671	0.78	0.94	53	83	293 (0)	55 (0)	...
Maldives	1	0	0.84	0.00	100	0	0 (0)	0 (0)	...
Myanmar	172	181	0.75	0.81	58	66	55 (0)	41 (4)	P1
Nepal	36	234	0.26	1.99	39	76	12 (1)	39 (2)	P1
North Korea	3	14	0.01	0.00	0	36	0 (0)	0 (0)	...
Sri Lanka	115	105	2.12	1.86	45	88	0 (0)	0 (0)	...
Thailand	131	337	0.50	1.90	65	85	19 (1)	21 (0)	...
Total	4 550	11 881	0.32	1.57	39	71	2 827 (709)	3 334 (1 160)	...

Note. The nonpolio AFP rate is the rate per 100 000 children younger than 15 years. It does not include AFP cases pending classification, which would inflate the estimate.

^aTwo specimens collected within 14 days of paralysis onset.

^bReported confirmed polio cases based on clinical and virologic findings.

^cReported wild poliovirus types isolated in 1999.

It was recognized that WHO region designations could impose bureaucratic constraints in regard to promoting effective coordination between neighboring countries of different regions, Pakistan (Eastern Mediterranean Region) and India (Southeast Asia Region) being important examples.

To that end, WHO and UNICEF, with assistance from the South Asian Association for Regional Cooperation, convened a meeting of high-level representatives from Afghanistan, Bangladesh, India, Iran, Myanmar, Nepal, and Pakistan in March 2000 to reach consensus on synchronizing polio immunization activities and streamlining communication strategies to expedite immediate reporting of acute flaccid paralysis cases across borders.

North Korea and South Korea are also in different WHO regions, but it is unlikely that transmission exists in either. However, to be certified polio free, North Korea will need to rapidly improve its surveillance performance, and this presents a challenge for partnership coordination between 2 countries with long-standing political tensions.

The Southeast Asia Regional Office estimates that since 1994, contributions from external partner agencies have totaled approximately \$350 million. These contributions have been used to establish and coordinate surveillance activities and national immunization days across the region. It is also estimated that government in-kind contributions have been at least double the contributions from external sources, helping to cover costs of personnel, transport, and logistics.

Impact of Coordination on Polio Surveillance and Epidemiology

By 1999, all Southeast Asia Region countries had implemented active acute flaccid paralysis surveillance. Since 1997, 108 trained national surveillance medical officers in India have been strategically posted nationwide to assist health authorities in implementing active surveillance. In that country, 10 069 reporting units have been established to report acute flaccid paralysis cases weekly. Similarly, in 1999 Nepal deployed 8 surveillance medical officers, and Bangladesh deployed 16 officers (the latter was increased to 32 in 2000).

The nonpolio acute flaccid paralysis rate in Southeast Asia increased from 0.32 per 100 000 residents younger than 15 years in 1997 to 1.57 in 1999 (Table 1). In 1997, only Sri Lanka had a nonpolio acute flaccid paralysis rate above 1 per 100 000. By 1999, India, Nepal, Sri Lanka, and Thailand had rates above 1 per 100 000, and India, Myanmar, and Bangladesh had rates above 0.7 per 100 000. In 1999, North Korea reported 14 acute flaccid paralysis cases, all pending classification.

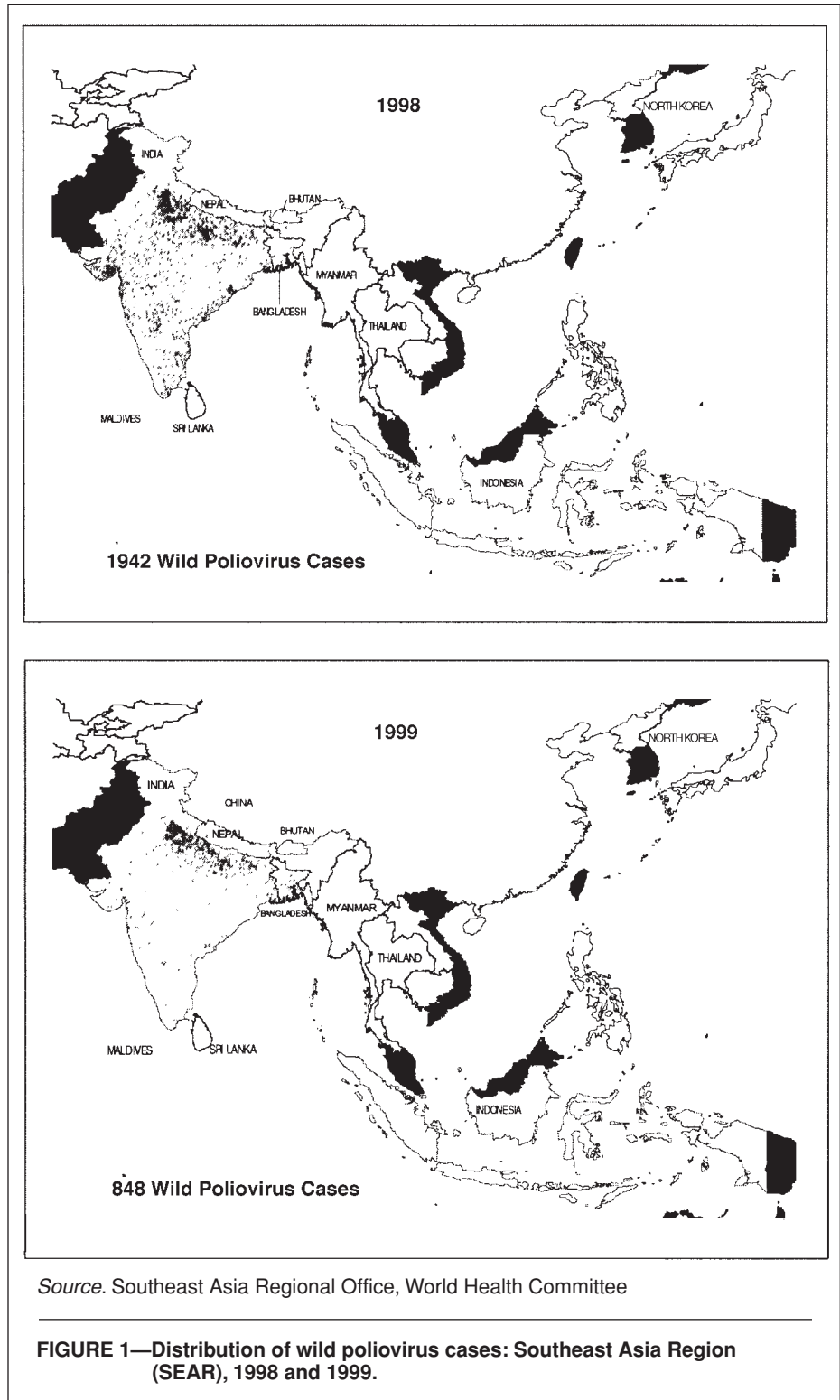


FIGURE 1—Distribution of wild poliovirus cases: Southeast Asia Region (SEAR), 1998 and 1999.

The percentage of acute flaccid paralysis patients with 2 adequate stools (2 stools collected within 2 weeks of paralysis onset) in Southeast Asia increased from 39% in 1997 to 71% in 1999 (Table 1). In 1999, 2 adequate stools were collected for more than 80% of the acute flaccid paralysis cases reported in Indonesia, Sri Lanka, and Thailand; more than

70% of the cases reported in India and Nepal; and more than 60% of the cases reported in Myanmar.

Because the investment in surveillance occurred in 1997, the peak reported number of polio cases occurred in 1998 (see Figure 1 for a distribution of cases in the region). Southeast Asia accounted for 75% (4775) of all polio

TABLE 2—Wild Poliovirus Isolation: Southeast Asia Region, 1997–1999

Poliovirus Type	1997	1998	1999
Type 1	634	1741	429
Type 2	3	83	11
Type 3	78	192	732
Total	715	2016	1172

Note. Data include mixtures.

cases reported globally in 1998 and 52% (3334) in 1999. In addition, the region accounted for 85% (1942) of the wild-virus-confirmed polio cases reported globally in 1998 and 63% (1160) in 1999. Of all wild-virus-confirmed cases reported globally, India alone accounted for 85% in 1998 and 43% in 1999.

Even with improved surveillance, indigenous wild poliovirus was last isolated in Sri Lanka in 1993, in Indonesia in 1995, in Myanmar in 1996, and in Thailand in 1997 (Table 1). Bhutan and Maldives have been polio free for more than 10 years. Limited data are available from North Korea. In 2000, India, Bangladesh, and Nepal remained polio endemic.

Of the 1160 wild-virus-confirmed cases reported in Southeast Asia in 1999, 97% occurred in India (385 wild type 1, 11 wild type 2, 718 wild type 3, and 12 both type 1 and type 3), 2.3% occurred in Bangladesh (26 wild type 1 and 2 wild type 3), and the remainder occurred in Myanmar (4 wild type 1 due to importations) and Nepal (2 wild type 1). Bangladesh reported 28 virus-confirmed cases in 1999 (vs 8 in 1998), a number consistent with improved quality of surveillance (Tables 1 and 2). Nepal reported 2 wild-virus-confirmed cases in 1999 (vs 0 in 1998). Neither country reported virus-confirmed polio cases in January and February 2000.

The 4 wild type 1 poliovirus cases isolated in Myanmar were from the southern area bordering Bangladesh and were characterized, via genetic sequencing, as similar to those isolated in Bangladesh in 1999. The 2 wild type 1 poliovirus cases isolated in Nepal were from districts bordering Bihar and Uttar Pradesh.

India reported 1126 wild-virus-confirmed cases in 1999, as compared with 1942 in 1998, representing a 42% reduction in cases. Of the wild-virus-confirmed cases reported in India in 1999, 88% occurred in the northern states of Bihar (123), Delhi (730), Uttar Pradesh (773), and West Bengal (121). Delhi was the only state in India that reported an increase in wild-virus-confirmed cases from 1998 (47 cases) to 1999 (73 cases). In 1999, the 11 wild-virus-confirmed cases due to type 2 occurred in Uttar Pradesh (10) and West Bengal (1).

Of the 47 wild-virus-confirmed polio cases reported in India in January and February 2000,

19 occurred in Bihar, 20 occurred in Uttar Pradesh, 3 occurred in West Bengal, and 1 each occurred in Gujarat, Karnataka, Madhya Pradesh, Maharashtra, and Manipur; no cases were reported in Delhi. The 42 wild-virus-confirmed cases reported from Bihar, Uttar Pradesh, and West Bengal during January and February 2000 represented a 7% increase from the 39 cases occurring during the same period in 1999. Excluding Bihar, Delhi, Uttar Pradesh, and West Bengal, the 5 wild-virus-confirmed cases reported from India in January and February 2000 represented a 74% reduction from the 19 cases occurring during the same period in 1999.

Discussion

Effective international coordination of polio eradication activities requires well-functioning technical oversight and partner coordination groups, such as the Technical Consultative Group and the Interagency Coordinating Committee, to ensure that strategies stay on track and sufficient resources are available to do the job. Cross-border meetings between neighboring countries have proven essential for interrupting transmission of wild poliovirus in reservoirs that extend beyond national boundaries. These meetings have aided collaboration between countries toward synchronizing massive supplementary disease control campaigns, such as national immunization days, and have improved disease surveillance and reporting through less formal but more rapid channels of communication.

Data from the Southeast Asia Region-wide active acute flaccid paralysis surveillance system now provide an accurate description of the current status of wild poliovirus transmission, allowing resources to be properly targeted. The global burden of polio in Southeast Asia member states decreased from more than 75% in 1998 to 52% in 1999. Indonesia, Thailand, and Myanmar appear to be joining the polio-free countries of Bhutan, Maldives, and Sri Lanka. From 1998 to 1999, reported cases of polio increased in Bangladesh, a change consistent with improvements in surveillance.

Although polio has been markedly reduced in India, in northern India transmission of wild poliovirus has remained intense and most likely was a source of importations of virus into China in 1999, which had not isolated indigenous poliovirus cases since 1994.^{14,15}

The persistent circulation of wild poliovirus type 2 in parts of Bihar, Uttar Pradesh, and West Bengal in India suggests that pockets of susceptible children are not being vaccinated via either routine services or national immunization days.¹³

Lessons learned from polio eradication may serve as a paradigm for the international control of other infectious diseases such as malaria and tuberculosis. Essential elements of this paradigm include effective leadership; appropriate use of, and new ways of working within, United Nations agencies such as WHO to streamline methods of work and communication between countries; a standardized surveillance strategy between countries; active surveillance supported by a team of qualified surveillance medical officers; an accredited laboratory network supported by state-of-the-art technologies such as genetic sequencing for tracking origins of infectious agents; performance indicators for monitoring progress and quality of activities; a technical oversight group that reviews and modifies control strategies; a partner coordinating body that ensures sufficient resources; powerful civic society partners (e.g., Rotary International) that can effectively lobby national governments from within the country; and rapid dissemination of information to those who need it most.

Effective cross-border coordination of polio eradication activities requires a high level of commitment. Efforts such as the mobilization of 2.4 million volunteers and the involvement of 500 district immunization officers, 108 surveillance medical officers, a national polio surveillance unit, and other Ministry of Health and Family Welfare staff in India are enhanced when such approaches are duplicated and synchronized in highly endemic neighboring countries. In such situations, chains of transmission of wild poliovirus in migrant populations are less likely to be missed. □

Contributors

J.K. Andrus directed WHO's Southeast Asia Region polio eradication initiative and is the primary investigator and author of the paper. A. B. Thapa, J. W. Fitzsimmons, N. Withana, P. Abeykoon assisted with the analysis of the data. B. Aylward coordinates the global polio eradication initiative and contributed to the discussion section of the paper.

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