of Indian epidemiologists would head such teams for periods of 3–24 months each. As many as 90 epidemiologists would be participating at any one time. Each epidemiologist was given 5 days' training before going to the field. Particularly useful for this purpose was a series of slides prepared by WHO illustrating clinical smallpox and 2 case-history studies, one of which dealt with the day-by-day management and investigation of a smallpox outbreak and the other with the management of a district smallpox eradication programme. (The latter eventually found its way into the syllabus of the Harvard School of Business Administration.)

As the autumn campaign began, there were only 26 epidemiologists in the field (Table 15.16). Each epidemiologist in the high-incidence states worked in a zone covering an average of 5–6 districts (approximately 10 million people) and had as his counterpart the division and/or district health officer responsible for the area. The special teams conducted training sessions for district and local staff to explain and organize the searches. In addition, they supervised the implementation and evaluation of surveillance activities and verified the diagnosis when cases were reported. When smallpox was detected, they organized outbreak containment and identified the source of infection.

Additional vehicles were essential and these were quickly obtained through the purchase by WHO of Jeeps manufactured in India. For WHO, this was a departure from a long-standing policy that the country itself should purchase locally produced equipment and supplies. Prompt delivery of the vehicles would have been impossible if traditional procedures had been followed—i.e., the purchase of Indian-made Jeeps by the government or the purchase of foreign-made vehicles by WHO. To have manoeuvred such a purchase through the complex Indian bureaucracy, even with the highest level of government support, would have taken anything up to a year; the delivery of vehicles from foreign sources was even more protracted at that time. The Indian-made Jeeps, although more susceptible to mechanical failure, were simpler in design and easier to repair. A most important consideration was that spare parts were widely available and there were many mechanics who were familiar with the vehicle. On balance, the Indian Jeeps proved more utilitarian than did imported vehicles.

Each of the epidemiologists was assigned a driver and a paramedical assistant and given a monetary advance (an imprest account) to be used, as necessary, for petrol and vehicle repair, travel allowances and supplies. The funds were accounted for at regular intervals before further advances were made. The disbursement of funds for the discretionary use of the field epidemiologists was also a departure from customary administrative practice, but it was one of the most important steps in facilitating the execution of the programme.

The strategy of the search programme and of the surveillance–containment activities was explained in detail at state-level meetings presided over by state officials and attended by senior officials of the national government and WHO, as well as by state and divisional and/or district health officers. These discussions were followed by similar meetings at the divisional level (for states with a divisional structure) convened by the commissioners of the divisions and attended by chief medical officers of health from the districts and municipal corporations. Meetings were then held at the district level, attended by the district health officers and primary health centre medical officers. Lastly, searchers and

Table 15.16. India: number of special epidemiologists working in the field, October 1973–July 1975

State	October 1973		January 1974		June 1974		January 1975		July 1975	
	International	National	International	National	International	National	International	National	International	National
Uttar Pradesh	5	5	6	6	9	18	11	13	6	8
Bihar	2	3	4	6	17	18	28	20	10	19
West Bengal	2	0	2	0	3	0	2	0	7	2
Madhya Pradesh	2	3	3	4	1	5	2	2	0	2
Eastern states	0	2	0	1	0	4	0	5	1	8
Other states	2	0	3	0	3	1	3	0	3	0
Subtotal	13	13	18	17	33	46	46	40	27	39
Total	26		35		79		86		66	

Plate 15.9. Project vehicles in Patna, Bihar State, at the beginning of the programme.

supervisors at each primary health centre were instructed in the specific techniques of search, outbreak containment and reporting. Such meetings at different administrative levels were subsequently conducted before each new search; the experiences of the previous search were evaluated and additional or revised procedures implemented.

To organize the numerous meetings and to develop strategy over the extensive area involved required an extraordinarily intensive effort on the part of the Central Appraisal Team. As an illustration of this endeavour, one may cite the experience of a member of the team who travelled more than 1800 kilometres by car in 5 days, during which he participated in 7 district and regional meetings. To do so necessitated driving all day and through the night; the team member and his driver shared this task, alternately driving and sleeping in the cramped Jeep.

The organizational plan called for one search worker to visit one village or section of a city each day. The hundred or more villages in each primary health centre area were divided up among the staff of 15–20 health workers. To facilitate supervision, a search schedule determined which worker would be in which village on which date. Each search was planned to be completed within 7–10 days. A supervisor oversaw the work of 4 or 5 workers and was assigned villages to be checked at random.

The searchers were instructed to show the WHO smallpox recognition card (see Chapter 10, Plate 10.11) and to inquire about any suspected cases that had occurred during the preceding 2 months. All village leaders and watchmen were to be contacted, as well as schoolteachers and their pupils, and persons congregating in tea-shops and market areas. Two or 3 houses in each of 4 parts of a village and the section of a village or town in which the poorest families lived were also to be visited. When the teams travelled from village to village, they were instructed to stop at brick kilns, bus stands, migrant camps and festivals to solicit reports of possible cases of smallpox.

Suspected cases were to be notified immediately to the primary health centre physicians, who were asked to verify the diag-

nosis. In addition to the assessment of work by the supervisors, each primary health centre medical officer was expected independently to assess one village or urban area assigned to each supervisor; each district-level supervisor was expected to visit one village, one school and one market in each primary health centre area; and each state surveillance team was expected to check 100 villages, 10 markets and 30 schools after each search. Areas selected for assessment were the least accessible villages and those most distant from the primary health centre. It was assumed that if the work was well done in the more distant and difficult areas, it was likely to be satisfactory in the areas easy of access. Radio, press, and other media were utilized to inform the public where to report cases of smallpox.

The first searches in the highly endemic states began in September. With such large populations and with so many health staff involved, the logistic requirements were formidable, as will be appreciated from the following inventory of material supplied to West Bengal for its first search: 100 copies of the Operational Guide; 10 000 small smallpox recognition cards and 3000 large recognition cards; 100 copies of each district map to be used to plan search workers' schedules; 3000 copies of the searchers' village-by-village schedules; 16 000 copies of forms for recording the results of the village visit; 400 copies of forms for listing outbreaks; and 3000 copies of the weekly reporting form to be dispatched from the primary health centres to the district. For a country-wide search, it was calculated that 8 tonnes of forms would be necessary.

Because of floods, only 9 out of 16 districts in West Bengal could be reached during the September search; but only 75 cases of smallpox were detected. It was uncertain whether the search had been good and the few cases that existed had been found, or whether it had been poor and many cases had been missed. However, a more extensive search conducted throughout the state in early October identified only 143 infected villages among West Bengal's 38 000 villages and 137 towns. Moreover, Calcutta, which many had feared might harbour extensive foci, had far fewer cases than had been expected.

The encouraging reports from West Bengal were quickly followed by alarming—almost unbelievable—reports from Uttar Pradesh and Bihar. During the week preceding the search, only 354 cases in 21 districts had been reported in Uttar Pradesh and only 134 cases in 8 districts in Bihar. However, the 1-week October search revealed 1525 outbreaks with 5989 cases in Uttar Pradesh and 614 outbreaks with 3826 cases in Bihar (Fig. 15.15; Table 15.17). It should be noted, however, that outbreaks occurred in only

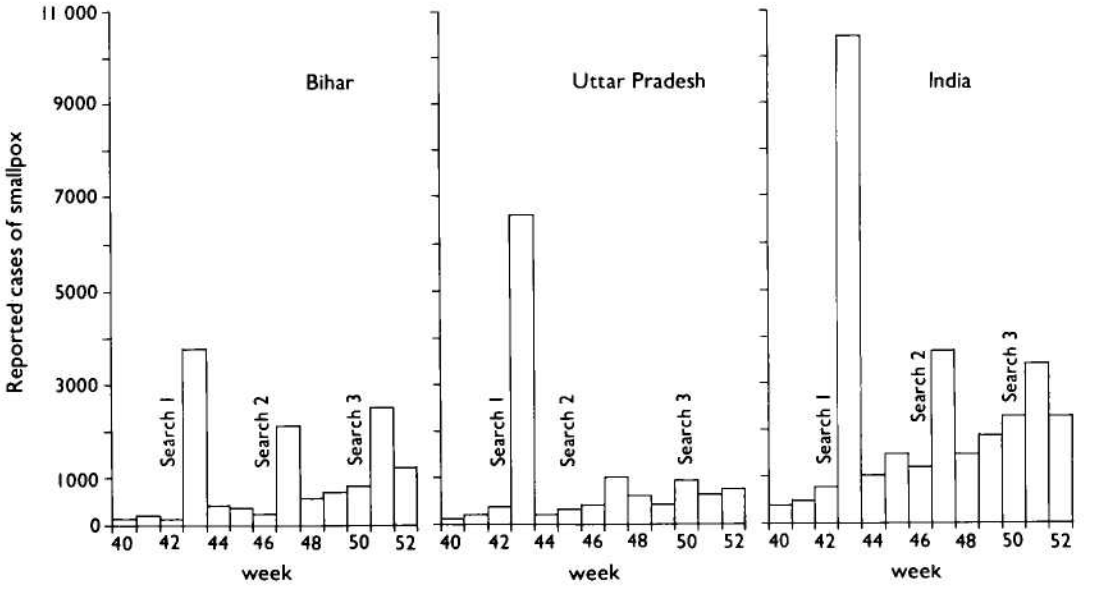


Fig. 15.15. Bihar State, Uttar Pradesh State, and India as a whole: number of reported cases of smallpox, by week, showing results of special searches, October–December 1973.

Table 15.17. Bihar, Uttar Pradesh and Madhya Pradesh: results of the 1973 search for outbreaks of smallpox

State	Month of search	Number of towns and villages	Number of villages with new outbreaks (% of total)	Number of municipalities with new outbreaks	Total number of new outbreaks found	Number of new cases found
Bihar	Oct.	67 727	601 (0.9)	13	614	3 826
	Nov.		484 (0.7)	21	505	2 459
	Dec.		385 (0.6)	20	405	2 619
Uttar Pradesh	Oct.	112 854	1 483 (1.3)	42	1 525	5 989
	Nov.		390 (0.3)	24	414	1 711
	Dec.		309 (0.3)	22	331	1 148
Madhya Pradesh	Nov.	71 116	164 (0.2)	6	170	1 216
	Dec.		51 (0.1)	2	53	215

1.3% of all villages in Uttar Pradesh and in only 0.9% in Bihar. However, smallpox was found in 42 out of the 293 municipalities in Uttar Pradesh, in 13 out of 161 in Bihar, and in almost all districts of both states.

The staff had cause for alarm because, in October, smallpox incidence was at a seasonal low. Moreover, the percentage of villages then infected was equivalent to the percentage infected *at any time* during the course of an entire year in the studies by Dr D. B. Thomas and his colleagues in Sheikhupura District in Pakistan (Thomas et al., 1972; see Chapter 14). Until this time, Sheikhupura District had been considered to be the prototype of a district with an unusually high incidence of smallpox in the generally well-vaccinated Indian subcontinent.

Despite the extensive planning and training, assessment revealed that many villages, indeed entire areas, had not been searched, and thus even the high figures recorded understated the problem. With smallpox present throughout both states and in many urban areas, it was apparent that when transmission rates increased, a major epidemic would be possible. In neither state were the health services functioning well and a 3-month period of intensive training and supervision provided little time in which to improve the performance.

The November and December searches were more thorough than the October search. Nevertheless, the number of infected villages which were discovered decreased in both states—more sharply in Uttar Pradesh, suggesting that the new strategy was having an impact. In Madhya Pradesh, geographically India's largest state, the first search was delayed until November because of floods. The results there were highly encouraging. Only 170 outbreaks were found in November and only 53 in December.

Searches in 8 "low-incidence" states revealed only 4 with outbreaks and, during 2 separate searches, fewer than 200 cases were discovered in each (Table 15.18).

Of 10 states which had been expected to be free of smallpox by September, only Andhra Pradesh was found to have had outbreaks, and, in all, only 197 cases were discovered (Table 15.19).

As 1973 ended, it was apparent that large areas of India had remained free of smallpox (Fig. 15.16), and the search programme had confirmed this. In December only 6 states recorded 100 or more cases, and 2 of them—Bihar and Uttar Pradesh—accounted for 84% of the total (Table 15.20; Fig. 15.17). Although the total number of cases recorded in India was 88 114, the highest since 1958, reporting was far more complete than it had ever been.

The autumn campaign had shown that it was possible to mobilize health resources effectively throughout entire states to search for cases and to contain outbreaks. However, with smallpox still widely prevalent in the 4 central states and the period of high transmission again beginning, it was clear that Phase Two of the campaign had to be extended into 1974.

In early January 1974, Henderson had meetings in New Delhi with Indian and WHO staff to assess possible strategies and needs for the coming months. The situation was critical. If the intensified search campaign was to continue, a commitment of additional funds was urgent. Funds earmarked for India in the WHO regular budget were sufficient to cover the campaign activities for 2–3 more months at most. To obtain additional money from WHO was a problem. WHO's budget for smallpox eradication had remained at a constant level since 1967. The funds had been proportionately

Table 15.18. India: searches for outbreaks of smallpox in low-incidence states and union territories, 1973

Low-incidence state or union territory	Number of searches	Average number of villages searched	Personnel complement	Number of outbreaks revealed	Number of cases revealed
Chandigarh	2	25	39	0	0
Gujarat	1	11 145	4 000	0	0
Haryana	2	7 840	1 500	1	1
Jammu and Kashmir	2	3 233	650	53	183
Maharashtra	2	17 954	2 563	0	0
Orissa	2	57 519	4 384	22	135
Punjab	1	12 564	1 500	0	0
Rajasthan	2	29 432	1 029	24	130
Total	–	139 712	15 665	100	449

Table 15.19. India: searches for outbreaks of smallpox in smallpox-free states or union territories, 1973

Smallpox-free state or union territory	Number of searches	Average number of villages searched	Personnel complement	Number of outbreaks revealed	Number of cases revealed
Andhra Pradesh	2	19 079	4 592	23	197
Arunachal Pradesh	1	384	138	0	0
Himachal Pradesh	3	23 998	700	0	0
Karnataka (Mysore)	1	15 565	2 636	0	0
Kerala	2	272	633	0	0
Manipur	1	1 068	138	0	0
Meghalaya	2	3 470	200	0	0
Mizoram	1	380	87	0	0
Tamil Nadu	1	16 799	2 654	0	0
Tripura	1	1 874	200	0	0
Total	–	82 889	11 978	23	197

Table 15.20. India: number of reported cases of smallpox, by state and union territory and by month, 1973

State or union territory	Population[a] (millions)	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
South[b]														
Andhra Pradesh	46.9	202	194	197	91	179	74	70	13	50	81	83	61	1 295
Goa, Daman and Diu	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0
Karnataka (Mysore)	31.6	0	0	5	0	0	0	1	0	0	0	0	0	6
Kerala	23.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maharashtra	54.3	1	27	23	8	16	45	34	3	0	0	1	0	158
Orissa	23.7	27	121	365	275	137	173	52	51	23	36	78	38	1 276
Tamil Nadu	44.4	0	1	1	1	0	0	0	0	0	0	0	0	3
East														
Arunachal Pradesh	0.5	0	0	0	0	0	0	0	0	0	0	1	1	2
Assam	15.8	0	28	13	33	26	51	18	19	35	21	80	134	458
Manipur	1.2	0	0	11	2	0	0	0	0	0	0	0	0	13
Meghalaya	1.1	0	0	0	0	0	0	0	0	4	0	0	26	30
Mizoram	0.4	0	0	0	1	0	0	0	0	0	0	0	0	1
Nagaland	0.6	0	0	0	0	0	0	0	0	0	45	0	0	45
Tripura	1.7	0	0	0	1	2	6	0	0	0	0	0	0	9
West														
Chandigarh	0.3	0	0	0	0	0	0	0	0	0	0	0	1	1
Delhi	4.4	17	17	21	43	36	18	5	2	2	6	0	1	168
Gujarat	28.8	7	0	0	0	0	1	1	0	0	0	0	0	9
Haryana	10.8	40	22	10	18	23	61	7	6	0	0	1	0	188
Himachal Pradesh	3.7	0	0	1	1	0	0	0	0	0	0	0	0	2
Jammu and Kashmir	5.0	20	12	4	111	120	75	65	56	31	39	117	291	941
Punjab	14.6	6	31	9	3	6	7	0	3	0	0	0	0	65
Rajasthan	27.8	123	217	151	168	67	78	31	0	0	0	24	18	877
Central														
Bihar	60.7	632	1 226	1 274	2 639	1 773	934	1 382	596	548	4 582	3 330	5 321	24 237
Madhya Pradesh	44.9	376	535	460	364	685	372	267	321	81	215	1 219	505	5 400
Uttar Pradesh	95.2	2 784	2 044	3 650	3 689	4 990	2 159	1 226	961	437	7 481	2 348	2 675	34 444
West Bengal	47.8	2 130	2 763	3 027	3 316	2 358	1 517	949	795	314	402	418	497	18 486
Total		6 365	7 238	9 122	10 764	10 418	5 571	4 108	2 826	1 525	12 908	7 700	9 569	88 114

[a] Population estimates based on United Nations (1985) data for all India proportionately allocated by state on the basis of the 1971 census.
[b] No cases were reported during this period in the union territories of Andaman and Nicobar Islands, Dadra and Nagar Haveli, Lakshadweep, and Pondicherry.

allocated to each of WHO's regional offices in 1967 and the proportions had not changed thereafter. With the certification of eradication in the Americas in 1972, it had been requested that the 1973 allocation for that region should be transferred to the South-East Asia Region. However, the proposal was turned down. Within the South-East Asia Region, some diversion of funds from Indonesia, now free of smallpox, was possible but the amount was not great. Meanwhile, repeated appeals to governments for support had brought generous donations of vaccine but little cash. A further emergency appeal was considered but thought to be futile because governments could seldom respond to such requests in less than several months to a year. Although the programme in India had achieved a momentum which offered hope of success, little could be done without additional resources and there appeared to be no solution forthcoming. Henderson returned to Geneva to consult the newly elected Director-General, Dr Halfdan Mahler. Later that week the WHO Executive Board was to meet. On the agenda was the question of how to use US$900 000 allocated to China, a new Member State of WHO, which had declined to accept WHO funds provisionally allotted for the support of its health programmes. The Director-General agreed immediately that a cable could be sent to India indicating that these funds would be used for its smallpox eradication programme, a decision later endorsed by the Executive Board. Another emergency in an apparently never-ending series of financial crises in the programme had been averted.

The Darkest Months of the Programme, January–June 1974

In January 1974 optimism prevailed. Funds were available to continue the programme, case notification was far more complete than ever before, and the search programmes were showing steady improvement in all states. In Bihar, in which the greatest numbers of cases were being recorded and the health services were the least adequate, the programme office reported that 50% more villages had been visited during the third search, in December 1973, than during the first in October. Despite a more extensive search and despite seasonally higher transmission rates, fewer villages with new outbreaks had been found.

The results in Uttar Pradesh had been even better, with the number of newly found outbreaks declining from 1525 in October to 331 in December. Progress in West Bengal was no less encouraging. There, Arita had introduced a new system to document progress in the programme. From October

Plate 15.10. Implementing the search programme required extensive field work by national and international staff. **A**: Ram Rakha Arora (b. 1925), an Indian member of the Central Appraisal Team in West Bengal. **B**: *Left*: Lawrence Brent Brilliant (b. 1944), an epidemiologist from the WHO Regional Office for South-East Asia; *right*: Anatolij N. Slepushkin (b. 1929), an epidemiologist from the Smallpox Eradication unit at WHO Headquarters.

1973, each newly discovered outbreak was added to a master list as an "active outbreak" and not removed from the list until 4 weeks had elapsed since the last case. At the end of December, there were only 124 active outbreaks in the whole of that populous state. In Madhya Pradesh, the last of the 4 key central states, a search conducted during 7–12 January 1974 revealed only 49 new outbreaks, two-thirds of which consisted of 3 cases or less. Of 5000 outbreaks discovered in these 4 states between October and December, it was estimated that not more than 1700 were still active. In the other states, the number of reported cases—many of them resulting from importations—remained low. Meanwhile, Bangladesh reported that only 172 of its villages were infected; in Nepal, virtually all outbreaks were said to have resulted from importations.

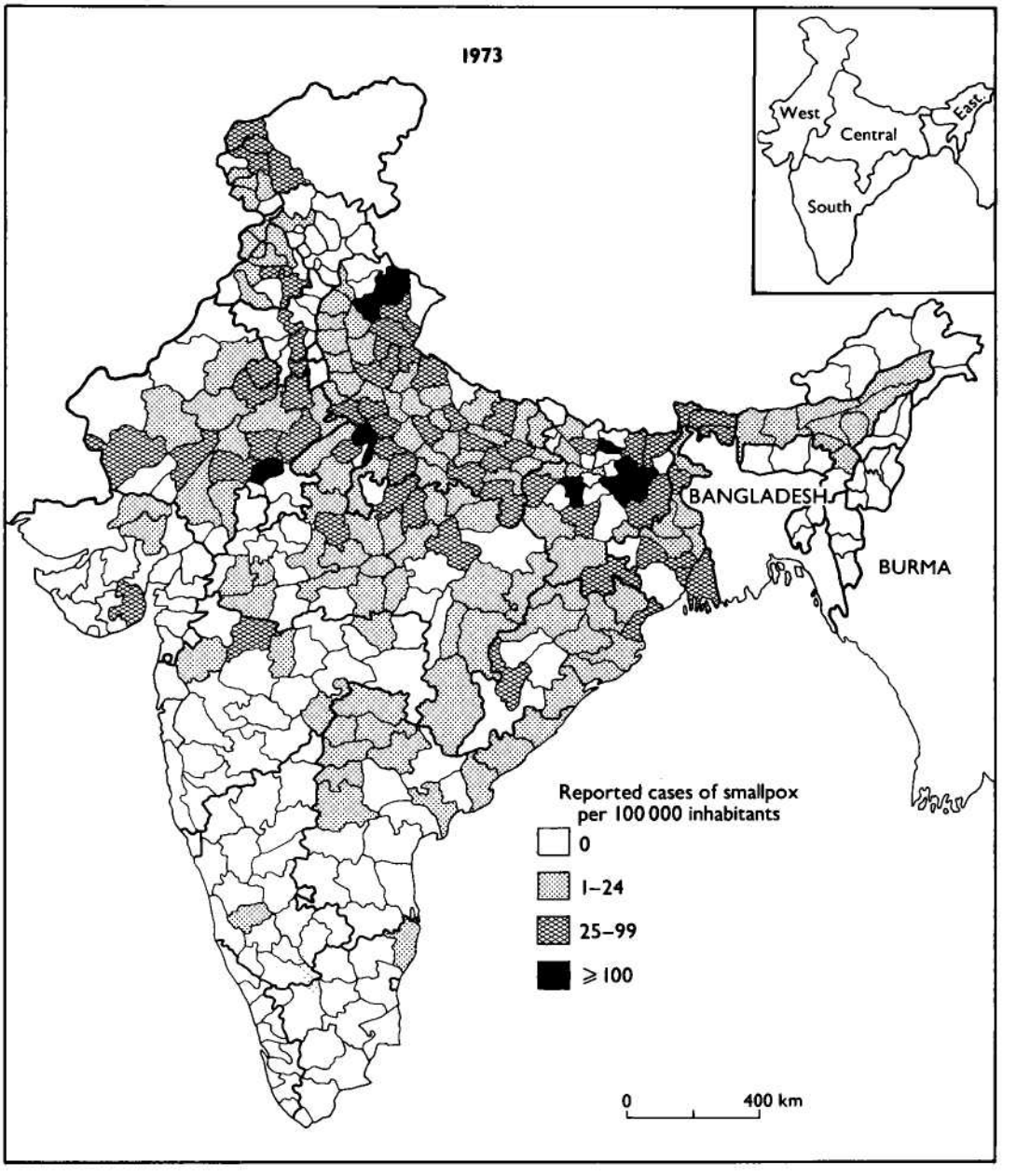


Fig. 15.16. India: number of reported cases of smallpox per 100 000 inhabitants, by district, 1973.

The Dedication of the Smallpox Programme Staff

The commitment and determination of staff who worked in the programme were extraordinary and indeed might well be the subject of a separate book. The meeting in New Delhi on 1 January 1974 of the Indian and WHO Central Appraisal Team and Henderson provides an illustration. All members of the team had been working a 7-day-week for nearly 4 months, travelling to some of the country's most remote and inhospitable areas in a frantic effort to motivate the army of health workers to contain the vastly larger number of outbreaks than anyone had foreseen. All had lost weight and were exhausted, one person had incapacitating renal colic, a second a painful facial herpes zoster infection, a third a serious fungus infection of the foot (which eventually required surgery) and a fourth atypical pneumonia with high fever and pleuritic pain. The only question asked at the meeting was how to find additional resources to sustain the momentum. When Henderson expressed scepticism of their own ability to work, let alone to continue the schedule proposed even if given the needed resources, the reply was simply: "We've considered the question and have decided that things can't get worse; therefore they must get better".

Exemplifying this determination in the field was a 50-year-old Indian professor of social and preventive medicine, Dr T. P. Jain, who was assigned as an epidemiologist in a flood-stricken area of Assam. Investigation and containment of many of the outbreaks required wading from house to house in areas in which leeches were legion and snakes a problem. A devout member of the Jain religion, he had requested a week's leave to attend ceremonies in another state commemorating the 2500th birthday of Mahavira, founder of the religion, a long-anticipated and sacred event. Another epidemiologist, arriving in the area to check the existing outbreaks in Jain's absence, found him waist-deep in water trudging from house to house, unwilling to leave for even a day so long as smallpox persisted in his area.

The commitment of the government to the programme was demonstrated early in 1974, when Dr Sharma was promoted to the position of Commissioner of Rural Health while retaining responsibility for smallpox eradication. Dr Sharma was widely known and respected among professional health staff and politicians alike for his expertise in the field of communicable diseases and for his executive ability. He had the full support of the Minister of Health and Family Planning, Dr Karan Singh. His commitment to the surveillance–containment strategy was total, and this he communicated to national and state officials on frequent visits to the field. It was important that he did so because the Director-General of Health Services, to whom he was subordinate, adhered to the traditional view that only a thorough mass vaccination campaign could succeed in eradicating smallpox, a view he expressed on frequent occasions. In part because of this contradictory advice, state officials in Bihar and occasionally in Uttar Pradesh were to call periodically for the suspension of search and containment activities in favour of total mobilization for a mass campaign to vaccinate everyone in the state. The mass vaccination approach was more easily understood and although it had been demonstrably unsuccessful in the past, there was the belief that if the health personnel were *really* properly organized and motivated the objective of 100% vaccination could be achieved. Dr Sharma's appointment ensured that the basic surveillance–containment strategy would be sustained.

A summary statement appearing in a WHO South-East Asia Regional Smallpox Surveillance Report (4 February 1974, unpublished) is indicative of the optimism prevailing at the beginning of 1974:

> "The tremendous increase in smallpox activities in the region since October 1973 has had its impact. Smallpox is diminishing in many areas at a time when it traditionally increases ... proving that smallpox transmission can be interrupted even at the height of the smallpox season. Within a few weeks a decrease in the transmission of smallpox can be expected ... If programme activities can be maintained or increased, most areas in India and Bangladesh could interrupt transmission before the monsoons."

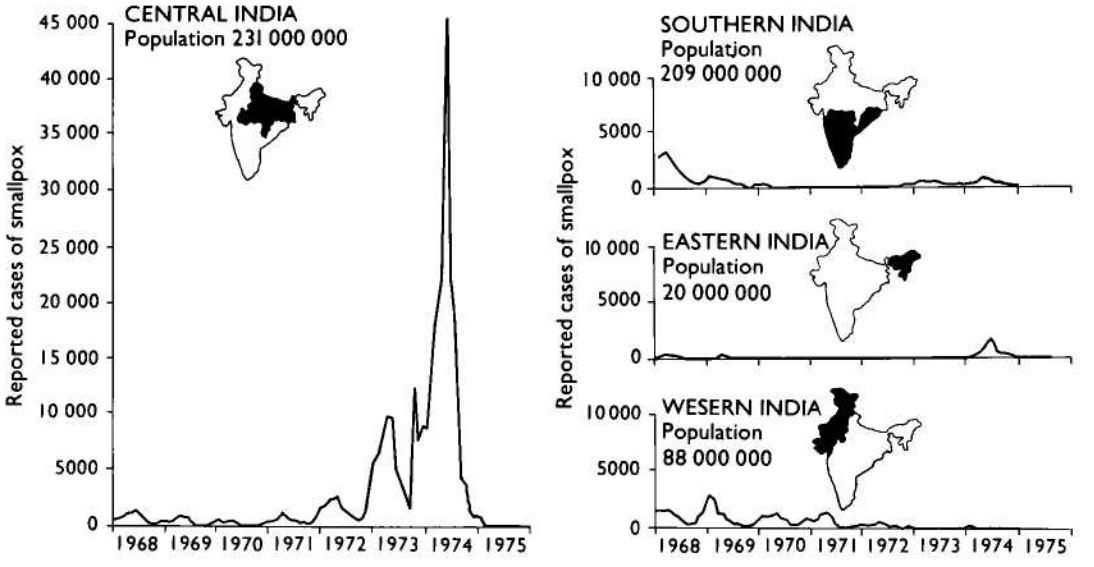


Fig. 15.17. India: number of reported cases of smallpox, by region, 1968–1975. (Population data for 1971 from Basu et al., 1979.)

BY COURTESY OF R S AGARWALA, 1974

Plate 15.11. Mudi Inder Dev Sharma (b. 1919), the Commissioner of Rural Health for India, vigorously and enthusiastically supported the programme from early in 1974 through extensive travel and personal inspiration. He is using the WHO smallpox recognition card to ask villagers in Uttar Pradesh State about possible cases of smallpox.

It was to be the last optimistic statement for many months.

In February 1974, the fourth search was conducted in Bihar. It revealed 1170 new outbreaks in villages and 18 in urban areas, almost 3 times the number (405) found in December, and more than twice as many cases as in January—10 697 as against 4816 (Table 15.21). The most seriously affected areas were the eastern districts. From here, smallpox began to spread to West Bengal (65 importations by mid-February) and to Nepal (11 importations).

Additional Indian and WHO epidemiologists were hurriedly recruited and assigned to Bihar. The fifth search (11–16 March) revealed 2374 new outbreaks, double the number found in February: more than 7000 cases were recorded during the search period (Fig. 15.18). By the end of the fifth search, there were 3682 active outbreaks in the state. Containment policies at this time called for the vaccination of residents only in the 20–30 houses adjacent to infected households. Even so, there were too few surveillance and containment teams to be able to visit more than a small proportion of the outbreaks, which were detected in many areas, and even the minimal containment measures were poorly executed. Desperate for additional help to supervise the search and containment programme, senior programme staff decided to recruit recent medical school graduates and, after a special training programme in New Delhi, 40 "junior doctors" were assigned to field work in Bihar. Eventually 140 were to participate (Jha & Achari, 1975).

Epidemic smallpox in Bihar was a problem of formidable proportions, and the occurrence of one natural or man-made calamity

Table 15.21. India: number of reported cases of smallpox, by state and union territory and by month, 1974

State or union territory	Population[a] (millions)	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
South[b]														
Andhra Pradesh	48.0	65	61	62	28	36	15	12	2	0	0	0	0	281
Karnataka	32.3	1	5	0	4	1	0	0	0	0	0	0	0	11
Kerala	23.5	0	0	2	1	1	0	0	0	0	0	0	0	4
Maharashtra	55.6	160	71	36	41	91	31	12	6	0	0	0	0	448
Orissa	24.2	53	64	347	365	564	259	211	136	43	14	10	103	2 170
Tamil Nadu	45.4	0	0	0	9	3	1	2	0	0	0	0	0	15
East														
Arunachal Pradesh	0.5	0	0	1	0	1	0	0	0	0	0	0	0	2
Assam	16.1	25	187	244	898	1 128	1 914	467	423	377	272	265	43	6 243
Manipur	1.2	0	0	0	0	4	1	0	0	5	1	0	0	11
Meghalaya	1.1	102	24	8	0	233	53	46	6	11	9	5	1	498
Mizoram	0.4	0	0	0	0	0	0	0	0	0	0	0	0	0
Nagaland	0.6	0	0	0	2	3	22	18	0	0	0	0	0	45
Tripura	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0
West														
Chandigarh	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0
Delhi	4.5	15	54	16	12	19	6	16	2	2	0	0	0	142
Gujarat	29.5	0	0	3	1	1	0	0	0	0	0	0	0	5
Haryana	11.1	2	4	3	23	10	18	6	5	0	0	0	0	71
Himachal Pradesh	3.8	0	0	3	1	3	0	0	0	0	0	0	0	7
Jammu and Kashmir	5.1	306	78	118	98	90	36	27	0	6	1	0	0	760
Punjab	14.9	0	2	10	5	10	18	7	0	1	0	0	0	53
Rajasthan	28.4	14	8	2	1	1	0	8	1	26	0	0	0	61
Central														
Bihar	62.2	4 816	10 697	12 788	14 553	35 626	14 971	14 076	11 591	3 416	2 758	1 053	527	126 872
Madhya Pradesh	46.0	386	310	305	358	475	157	200	44	5	0	1	10	2 251
Uttar Pradesh	97.5	2 800	2 477	3 787	4 856	8 337	6 291	4 886	1 778	698	690	195	164	36 959
West Bengal	48.9	608	721	1 819	2 428	2 196	1 795	991	342	84	61	4	45	11 094
Total		9 353	14 764	19 554	23 684	48 833	25 588	20 985	14 336	4 674	3 806	1 533	893	188 003

[a] Population estimates by states are based on United Nations (1985) data for all of India proportionately allocated by state on the basis of the 1971 census.

[b] No cases were reported during this period in the union territories of Andaman and Nicobar Islands, Dadra and Nagar Haveli, Goa, Daman and Diu, Lakshadweep, and Pondicherry.

after another further hampered the eradication effort. Indian Airlines workers went on an extended strike, making it difficult to ship vaccine and for senior personnel to travel. The railways began to be extensively used until railway workers likewise went on strike. Meanwhile, the international oil crisis had developed and, in April, petrol costs in India doubled and shortages occurred. Drought in southern Bihar, sufficiently severe to require international assistance, resulted in the migration of large populations of refugees seeking food and spreading smallpox. This was soon followed by the most severe floods in a decade in northern Bihar and even more refugees fleeing in search of food and refuge. Civil disorder and political disturbances began to occur throughout Bihar and, over large areas, government authorities were totally occupied with maintaining law and order. Throughout this period, heroic efforts were made to ensure an adequate flow of supplies and to stockpile materials such as vaccine and reporting forms in anticipation of expected shortages; however, most supplies were barely adequate to meet the current needs.

That the programme in Bihar functioned at all was remarkable and for this due credit must go to its Smallpox Programme Director, Dr A. G. Achari, a conscientious and tireless worker who, with the officers of the Central Appraisal Team, Dr Foege and Dr Dutta, sought valiantly to mobilize a lethargic health staff and to sustain morale among the Indian and WHO epidemiologists, who were overwhelmed by the explosive spread of smallpox.

When it seemed that little else could possibly go wrong, the health workers in Bihar threatened to go on strike. Dr Achari, Dr Dutta and Dr Foege sought desperately to develop a contingency plan but with little support. The observation of one district health officer was characteristic of the attitude of some supervisory health staff: "If we

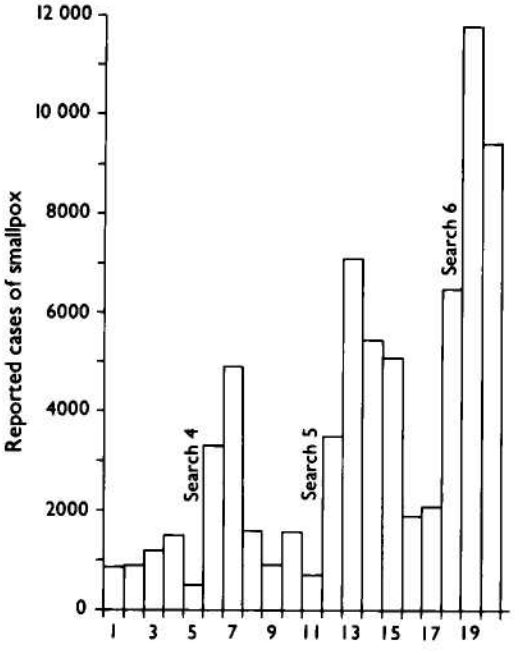


Fig. 15.18. Bihar State: number of reported cases of smallpox, by week, showing results of special searches, January – May 1974.

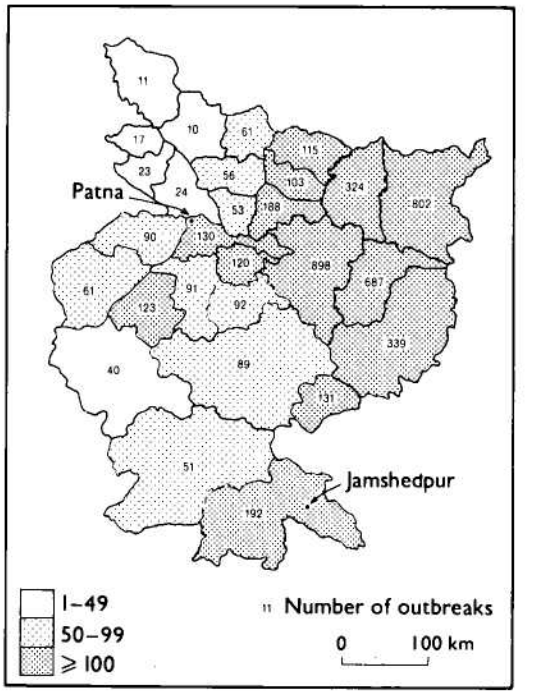


Fig. 15.19. Bihar State: number of active outbreaks of smallpox, by district, as of 5 May 1974.

don't have a strike, we don't need a contingency plan; if we do have a strike, it is no longer my responsibility."

The sixth search in Bihar (29 April–4 May) recorded 2658 additional outbreaks—the number of active outbreaks increasing to 4921. More than 7% of all villages and municipal areas in the state were infected, the most heavily afflicted being in the north-east (Fig. 15.19), where, in 3 districts, 25% of all villages were infected.

India's Director-General of Health Services, still an advocate of mass vaccination, became increasingly alarmed and advised Bihar's Minister of Health to withdraw staff from the infected areas and to begin mass vaccination campaigns in the areas still free of smallpox to prevent them from becoming infected. Dr Sharma, learning of this only after the minister in Bihar had begun to take action, protested direct to India's Minister of Health and Family Planning, Dr Karan Singh, and together they flew to Bihar to intercede. The Bihar minister rescinded his order. In an epidemic as extensive as that occurring in Bihar, some of the Indian and WHO programme epidemiologists began to speculate that Bihar might represent a special case in which the now well-tested surveillance and containment strategy might not be applicable.

Throughout May and into early June, the epidemic continued to intensify. With daytime temperatures normally exceeding 40 °C, field work became ever more difficult, morale began to deteriorate and, again, the question of a return to state-wide mass vaccination arose. The minister was more resolved than before and, in the June meeting of state and district programme officers, strongly advocated this approach. Senior programme staff argued in vain, until an Indian physician, working in one of the districts, pointed out in a deferential manner that he had grown up in a village and there, when a house was on fire, they put water on that house and not on all houses in the village. The minister reluctantly agreed to defer a mass vaccination campaign for one more month but only on the understanding that if no apparent progress had been made by then, mass vaccination would be initiated. Senior staff hoped that, even if containment were less than optimum, the seasonal decrease in transmission would partially stem the epidemic and so preserve what they believed to be the only possible effective strategy—surveillance and containment.

Plate 15.12. Karan Singh, Minister of Health and Family Planning of India from 1973 to 1977, provided strong political support for the programme and for the surveillance–containment strategy.

In the other states of India, the situation was better than in Bihar but not so good as had been expected in February. Uttar Pradesh was the next most heavily infected state. The numbers of reported cases and outbreaks had risen steadily since January, although less precipitously than in Bihar. A peak of 1905 active outbreaks was reached in May, with 8337 cases reported that month. Outbreaks were reported from 442 (51%) of the state's 875 primary health centres and in 47 of its 55 districts (Srivastava & Agarwala, 1975). However, 82% of the outbreaks occurred in only 15 districts, primarily in eastern Uttar Pradesh, where their large number precluded the taking of effective containment measures. Elsewhere in the state, with the support of the Director of Medical and Health Services and Family Planning, Dr G. P. Srivastava, the health staff had begun to function well.

In West Bengal, the number of active outbreaks increased steadily, from 124 in December to 556 following the seventh search in mid-April. However, more than 75% of the outbreaks took place in only 5 of the state's 16 districts, and here village volunteers began to be recruited and trained for containment operations, an effective practice later adopted in other states. The increase in the number of outbreaks in West Bengal was largely accounted for by importations, mostly from Bihar. Between January and May, programme staff documented 386 imported outbreaks, and others occurred as a result of spread from these importations.

Importations, principally from Bihar, Uttar Pradesh and West Bengal, accounted for an increase in the number of cases in Madhya Pradesh, Maharashtra and Orissa. Each state worked diligently and effectively to discover and contain the outbreaks as rapidly as possible, but by May, both the smallpox eradication staff and the general health service personnel were reaching a critical point of fatigue and frustration. Meanwhile, the eastern states, hitherto all but free of smallpox, experienced a sharp increase in the number of cases, resulting from importations from Bangladesh, Bihar and Uttar Pradesh. This was cause for additional alarm because, in the eastern states, health services were generally less extensive and not much better organized than those in Bihar. Although they were not populous states, road and rail services were poor and both search and containment activities were difficult to organize and to execute.

The unexpected and explosive epidemic of smallpox in Bihar and its spread to other states had required the mobilization of far more Indian and WHO epidemiologists (see Table 15.16) than had been foreseen and had necessitated the emergency purchase of more vehicles and supplies of all types than had been planned. By April, funds to support the smallpox programme were again at a low level. Requests were made to numerous governments for additional finances; few showed any interest and no country indicated it was in a position to act quickly in answering an appeal. Privately, many expressed scepticism about the programme's prospects of success. The reaction was not surprising in view of the fact that the number of cases of smallpox recorded in India in the spring of 1974 was the largest for nearly two decades. WHO's frequent appeals in the past for funds to bolster its malaria eradication campaign, and the continuing setbacks in that programme despite infusions of ever larger sums of money, were well remembered. Once again, the programme approached a critical point, but, unexpectedly, substantial help materialized from a new source, the Swedish International Development Authority (SIDA). In a casual conversation with the Personnel Officer of the WHO Regional Office for South East Asia—an official of Swedish nationality—Dr Grasset learned

Plate 15.13. Jarl E. Tranaeus (b. 1923), Head of the Development Co-operation Office of the Swedish Embassy in New Delhi from 1973 to 1978, persuaded Swedish authorities and the Indian government's Planning Commission of the need for substantial additional assistance to the smallpox eradication programme at a crucial moment.

that SIDA planned to examine alternative uses for Swedish funds which had become available because of the cancellation of another project in India. Discussions promptly followed with Mr J. Tranaeus, at the Swedish Embassy in New Delhi. Convinced, as few others were, that an effective and well-directed campaign was in progress whatever the smallpox incidence might suggest, he persuaded the Planning Commission of the government of India, as well as his superiors in Stockholm, of the merits of the programme. Within a few weeks, a memorandum of agreement had been signed on behalf of the governments of India and Sweden which made available to WHO US$2.8 million in support of the smallpox programme. With Mr Tranaeus's continuing enthusiastic interest, SIDA was eventually to provide US$10 million to the programme. The government of India also increased its own central allocation of funds. For 1974, a sum of US$13 million was made available for field operations.

Time was required to effect the necessary transfer of funds, but the Division of Budget and Finance in WHO Headquarters readily agreed to permit funds to be obligated even though they were not yet in hand. Meanwhile, the administrative staff in the WHO regional office were experiencing difficulties, because of the substantial expansion in the number of personnel in the programme receiving a stipend from WHO, the larger numbers of imprest accounts to be handled and the need to procure a greater volume of supplies (Table 15.22). It was essential that additional personnel should be recruited and that budget and finance operations should be established for the programme. The Center for Disease Control (formerly the Communicable Disease Center) in Atlanta, which was already providing many field epidemiologists, responded to this need by sending its most capable senior administrative staff to help to bring some order into an increasingly chaotic administrative situation. Beginning with the Center's Deputy Director, Mr William Watson, an exceptionally imaginative group of administrators worked tirelessly with the group of no less talented WHO administrative staff to provide essential services in support of the field staff.

Although the smallpox epidemic was featured more often and with greater prominence in Indian newspapers, little was known of the problem outside the country. However, in May 1974, the epidemic became international news. On 18 May 1974, India tested its first atomic device in an underground explosion in Rajasthan. At that time, the smallpox epidemic was at its height, more than 11 000 cases being reported in a single

Table 15.22. India: principal supplies and items of equipment provided by WHO, 1970–1976[a]

Item	1970	1971	1972	1973	1974	1975	1976	Total
Vehicles	0	48	36	37	191	36	0	348
Motor cycles	47	0	45	0	175	130	0	397
Bifurcated needles (thousands)	878	907	1 000	300	976	1 600	1 035	6 696

[a] Between 1972 and 1976, it is estimated that WHO, in addition, arranged to print and distribute the following material: approximately 31 million forms for use in reporting and in search and containment operations; 500 000 booklets for use in outbreaks and in market searches; 400 000 posters; 1 million smallpox recognition cards; and 500 000 other guides and miscellaneous publications.

week. International news reporters who had flown to India to cover the atomic test arrived just as the smallpox epidemic hit the headlines in the local press; international media coverage of both events was extensive. Programme staff repeatedly explained that more complete reporting accounted in major part for what appeared to be the largest epidemic for many years, but scepticism was prevalent and understandable.

Although the problem in Bihar was serious, the eradication programme throughout India was steadily improving and gaining momentum. Week-long village-by-village searches were being performed each month throughout the high-incidence states and less frequently in the others (Table 15.23). The number of those engaged in the searches was increasing (Table 15.24).

As serious and frustrating as the situation appeared, yet another disaster aggravated it—the Jamshedpur epidemic in Bihar State. Its discovery resulted from investigations in Madhya Pradesh. Special efforts had been made to interrupt transmission in Madhya Pradesh. It was one of the 4 central states considered to be of highest priority, and was geographically the largest state in India, with a population of 46 million. Most of the outbreaks which had been discovered during the autumn searches were in the northern and eastern districts of the state, bordering on Bihar and Uttar Pradesh. The December 1973 search had revealed only 215 cases and 53 new outbreaks. By the beginning of March 1974, and after 5 monthly searches of its 10 million households, smallpox appeared to be present in only a single, geographically limited focus, in a tribal area and one of the least developed parts of the state.

Table 15.23. India: frequency of active searches for outbreaks of smallpox, 1973–1975

State or union territory[a]	Number of searches		
	1973	1974	1975
High-incidence:			
Bihar	3	11	9
Madhya Pradesh	2	10	4
Uttar Pradesh	3	10	10
West Bengal	4	12	12
Low-incidence:			
Chandigarh	2	2	5
Delhi	0	3	4
Gujarat	1	3	5
Haryana	2	4	4
Jammu and Kashmir	2	6	6
Maharashtra	1	5	6
Orissa	2	5	6
Punjab	1	3	5
Rajasthan	2	2	4
Smallpox-free:			
Andhra Pradesh	2	7	4
Arunachal Pradesh	1	6	12
Assam	0	8	11
Goa, Daman and Diu	0	0	2
Himachal Pradesh	3	2	6
Karnataka	1	5	3
Kerala	2	3	5
Manipur	1	5	11
Meghalaya	2	8	11
Mizoram	1	6	9
Nagaland	0	4	11
Pondicherry	0	0	1
Sikkim	0	0	1
Tamil Nadu	1	4	6
Tripura	1	6	11
Total	40	140	184

[a] Relative incidence as defined in 1973.

Table 15.24. India: approximate number of workers, per search, 1973–1976

Year	India, total	High-incidence states	Low-incidence states	Smallpox-free states
1973	63 890	36 073	16 592	11 225
1974	80 847	35 509	33 916	11 422
1975	116 829	39 404	45 001	32 424
1976	134 412	43 688	54 261	36 463

In late March 1974, however, reports of smallpox outbreaks began to arrive from many areas of Madhya Pradesh which had been considered to be smallpox-free. Investigations revealed these to be the result of recent importations from the neighbouring state of Bihar. The source of infection of many was traced to an industrial complex in southern Bihar: Jamshedpur in Singhbhum District. *Adivassis* (tribal people) often travelled 300–800 kilometres to Jamshedpur from their homes in Madhya Pradesh in search of seasonal employment. If they became ill with fever, they returned to their native villages, where many subsequently developed rash and spread smallpox to others.

Dr Brilliant was dispatched to Jamshedpur in late April to assess the situation. He found a major problem of unexpected magnitude.

The epidemic in Jamshedpur, Singhbhum District, Bihar

The Jamshedpur industrial complex is one of India's most important steel-producing areas, its prosperity contrasting sharply with economically depressed neighbouring areas of southern Bihar, eastern Madhya Pradesh

BY COURTESY OF TATA INDUSTRIES

Plate 15.14. The office of Tata Industries, Jamshedpur, became the smallpox eradication headquarters for Chotanagpur Division, Bihar State.

and northern Orissa. As such, it attracted numerous seasonal workers, beggars and transients.

The special investigation began in early May. The District Medical Officer of Singhbhum disclosed that during the preceding 6 weeks, he had received 125 notifications of outbreaks in other districts of Bihar and in other states which were suspected of having originated in his district, and that 12–15 notifications were then being received daily. Little action had been taken, the government health structure in this district being poor. In addition to 27 primary health centres that reported to him, all of which were then known to have smallpox cases, there were 15 autonomous and separately administered health units in Jamshedpur (population, 800 000). The health units included small company towns, corporations, large colonies of railway employees and others. No one was charged with the task of reporting cases among the large migrant population, and the railways denied all responsibility for the reporting of cases from the areas they administered. Half the health units were found still to be using rotary lancets.

At the industrial complex, a group of heavy industries of the Tata group, officials professed ignorance of the problem but immediately agreed to provide help in a search of the city and of 1760 villages within a 45-kilometre radius. In a search that took place in mid-May, 50 physicians, 200 paramedical supervisors and 900 searchers discovered 1479 cases in the city and 726 cases in the 456 villages found to be infected (Basu et al., 1979). An intensive programme of containment and case detection was immediately undertaken. This involved, in addition to government and WHO health staff, personnel and transport provided by 7 of the Tata industries as well as voluntary organizations, including the Rotary Club, the Lions Club, the Bihar Flying Club, the local blood bank and the All-India Women's Council (Bharucha, 1975). All bridges and major roads were barricaded and no one was permitted to pass unless vaccinated. A special programme dealt with railway travellers, especially third-class passengers, of whom perhaps one-third travelled without tickets. Trains were diverted to special platforms, which permitted all passengers to be checked

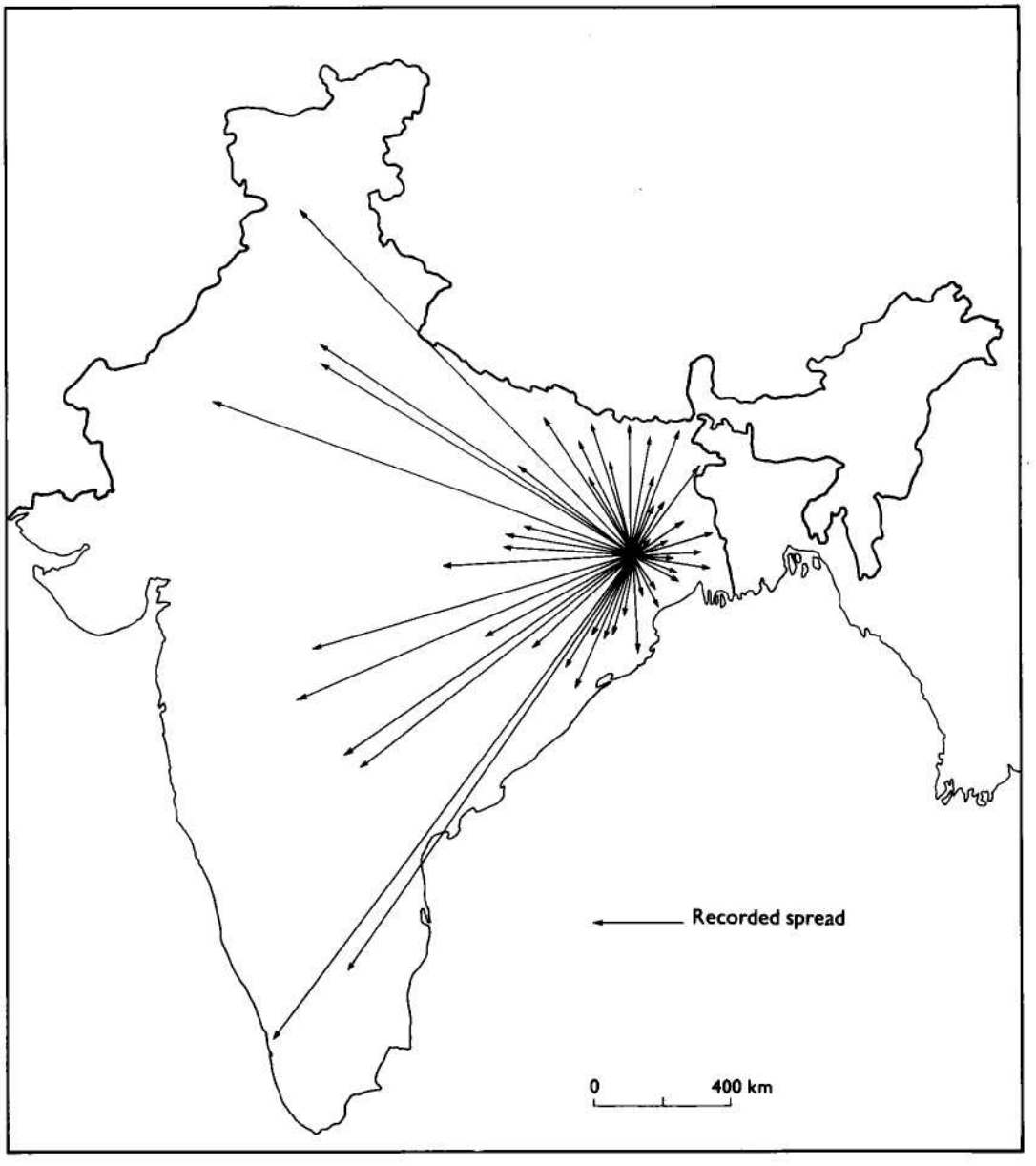


Fig. 15.20. Spread of smallpox from the Jamshedpur urban industrial complex to the rest of India, 1974.

when boarding or leaving a train. Checkpoints were established at bus stations, and employers ensured that workers and their families were vaccinated. Meanwhile, the containment of all known outbreaks began, an effort which in fact necessitated house-to-house vaccination of the entire urban complex and most of the surrounding villages.

Two months were required to bring the epidemic under control. Meanwhile, 300 outbreaks and at least 2000 cases occurred in 11 states of India and in Nepal as a result of travel from Jamshedpur (Fig. 15.20). The area most affected was Bilaspur District (Madhya Pradesh), with 484 cases in 72 villages.

A Redoubled Effort, June–December 1974

Early June 1974 was the psychological low point of the Indian smallpox eradication programme, if not of the global Intensified Programme itself. A 9-month intensive campaign had been conducted throughout India

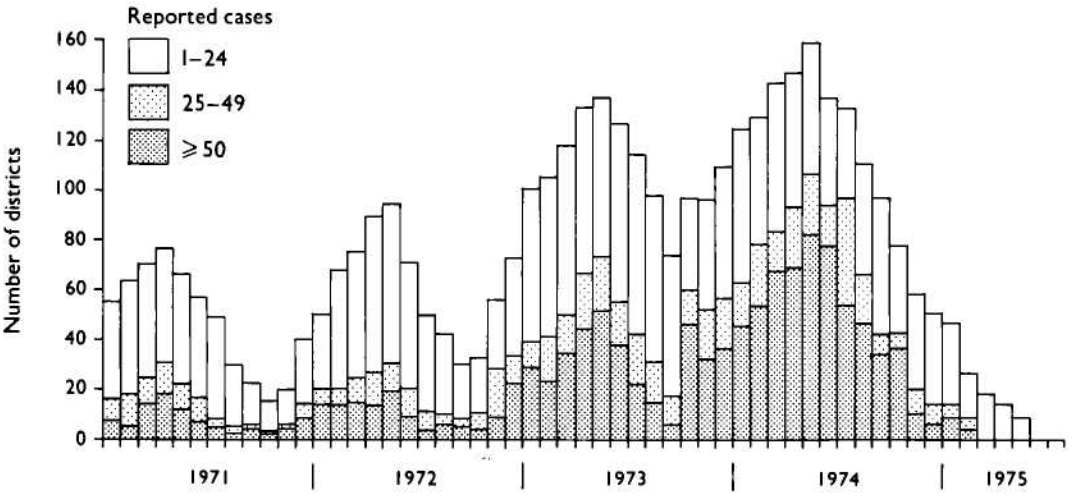


Fig. 15.21. India: number of districts reporting cases of smallpox, by month, 1971–1975.

with senior staff and numerous field staff working 7 days a week. Despite the large expenditure of money and effort to date, and despite what appeared to be an increasingly successful effort in surveillance and containment activities, there were 8664 known outbreaks. Moreover, up to the end of May, India had already recorded 116 188 cases, a number greater than that reported for the entire world during any of the preceding 6 years of the Intensified Programme. Cases were reported in May from nearly one-third of the districts in India, of which 80 reported 50 cases or more (Fig. 15.21). Many areas of India remained free of smallpox or had only a few outbreaks resulting from importations (Fig. 15.22), but the epidemic wave then surging through Bihar seemed to be moving both east and south. It was clear that the efforts made so far in Bihar had been inadequate to contain smallpox, and the states which appeared to be the next candidates for epidemic smallpox—Orissa to the south and the states to the east—had health services which were not much better in quality than those in Bihar.

During June, with the beginning of the monsoon period, smallpox transmission normally declined in India and the number of outbreaks diminished. However, with the disease so widely seeded throughout Bihar and adjacent areas, it was clear that unless a concerted effort were made to contain the outbreaks during the summer, smallpox would remain widely disseminated at the commencement of the next season and the experience of the spring of 1974 would be repeated. Activities of all types usually diminish in India during the summer months—the hottest, the most humid and the most difficult months of the year in which to work. A staff which had toiled to the point of exhaustion between September and May would have to mount one more effort.

On 17 June 1974, the Central Appraisal Team met the Secretary of Health and the Director-General of Health Services to discuss an emergency programme for the whole of India, but especially for Bihar. It was decided to increase the number of special epidemiologists from the 50 who were in the field at the time to more than 100. WHO would initially provide 12 additional international epidemiologists, and 6 non-medical surveillance officers; the government of India would attempt to recruit 40 epidemiologists. If that proved impossible, WHO would try to obtain the services of more international epidemiologists.

Six central-level surveillance teams would be established which would respond to emergency smallpox problems as they developed. State surveillance teams, hitherto restricted in travel to the state in which they were assigned, would be directed to cross state borders whenever necessary to seek the source of infection of outbreaks.

Three hundred additional containment teams would be recruited, each to be headed by recent Indian medical graduates. A further 375 Jeeps would be purchased or hired. To

fund these activities, SIDA offered additional financial assistance, which was rapidly made available.

It was recognized that special efforts would be required in Bihar. Following consultations between the staff of the WHO regional office, the Governor and the State Health Minister, the Chief Secretary of the State of Bihar sent a special letter to all district magistrates, informing them that as from the end of June they and the block development officers would assume responsibility for the conduct and organization of the campaign in their districts. Dr Achari would continue in his role as State Smallpox Eradication Programme officer but more effective senior administrative staff would replace the health service staff in bearing primary responsibility for the programme.

The president of Tata Industries was

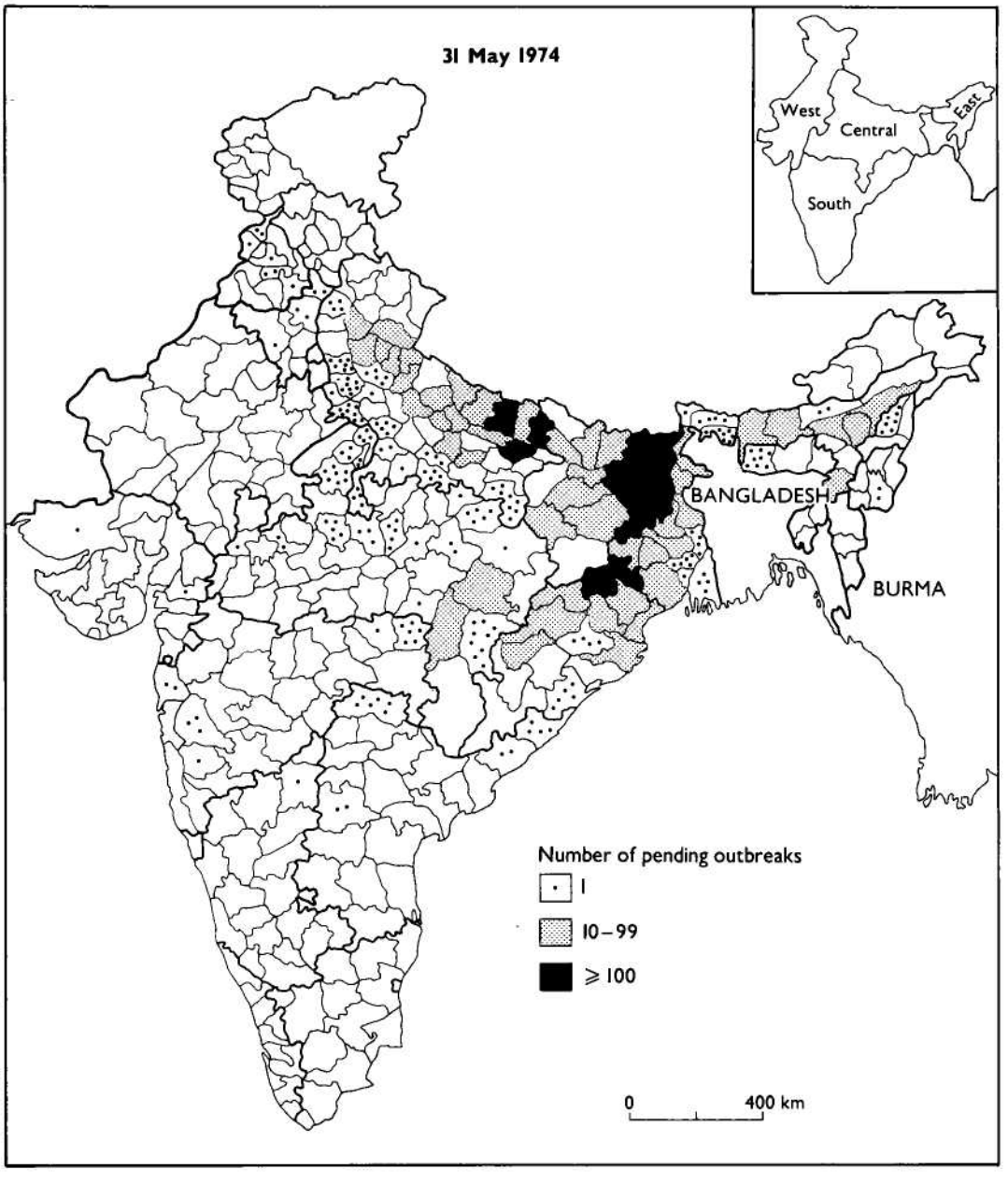


Fig. 15.22. India: number of pending outbreaks of smallpox, by district, as of 31 May 1974.

The Situation in India as Seen in June 1974

Memorandum, dated 24 June 1974, from the Chief of the WHO Smallpox Eradication unit to all smallpox eradication staff:

"The epidemics of smallpox now occurring in Bihar, eastern Uttar Pradesh and adjacent areas have been the subject of world-wide press interest during the past two weeks with many articles appearing in all major newspapers and news magazines. Providing perspective on the problem has not been easy. While there is no question but that Bihar and eastern Uttar Pradesh are heavily afflicted and represent now the "epicentre" of the global problem, the fact of a far more active programme and more complete reporting unquestionably magnifies the severity of the problem when comparing this year's and last year's data. Whatever the relative magnitude of the problem, it is clear that the most critical battle of the entire programme is now being fought on the Indo-Gangetic plain of Bihar, Uttar Pradesh and the adjacent states. Our success in these efforts over the coming months will be determining in regard to the goal of global eradication.

"The reporting of large numbers of cases as is now the case in Bihar, eastern Uttar Pradesh and adjoining areas, is of real concern but, at the same time, it may also be regarded as an encouraging sign. Unless outbreaks are found, they cannot be controlled. And one must recall the experience in Brazil when, in 1969, surveillance was first introduced into the programme. Smallpox incidence abruptly rose that year to reach the highest level in almost a decade, only to fall to '0' less than a year later. Can we do the same in these other problem areas? Unquestionably we can, provided there is full government support at all levels and that every effort continues to be made to find all cases and outbreaks and to contain them.

"While the epidemics in India have captured the headlines, equally newsworthy are the spectacular achievements in Pakistan. It is apparent that staff at all levels of the programme now realize that eradication is imminent and with this realization has come an even more energetic burst of activity."

approached for help in dealing with smallpox in the 6 southern districts of Bihar comprising Chotanagpur Division. He agreed to assist and the company's Board of Directors approved the expenditure of 7.2 million rupees (US$900 000) and the assignment of personnel and vehicles. An unusual semi-autonomous public and private sector programme was created in this division, involving personnel and equipment from WHO, Tata Industries, the government of India, the state of Bihar, and OXFAM, a private voluntary organization. The consortium participating in the Chotanagpur Division programme was to function capably and with remarkable cooperation over the following 12 months.

Deficiencies in the containment of outbreaks had proved to be a serious weakness of the programme in most states, particularly Bihar and Assam. Where smallpox outbreaks were few, state surveillance teams had usually assisted local staff in their investigation and in the vaccination of village residents. Where smallpox was widely prevalent, procedures called for the detection of all cases in the area and the vaccination of those in the 20–30 nearest households. The names of any absent household members were supposed to be recorded and the village visited on a later occasion to ensure that all were vaccinated. This directive was rarely followed, however. In many areas of the world, and indeed in many parts of India, simple containment measures had sufficed to stop transmission. In the more densely populated parts of India, however, they proved ineffective. Many persons left their homes during the day to go to the fields, to market or elsewhere; some who objected to or feared vaccination simply hid themselves and their children when the teams were in the villages; many visited relatives and friends, including those with smallpox, in other villages. The result was that even after intensive containment vaccination, numerous susceptible persons remained and smallpox transmission persisted.

It was therefore decided to systematize the containment activity in a manner that could be readily understood and widely applied and

BY COURTESY OF TATA INDUSTRIES

Plate 15.15. One of the 56 surveillance teams in Chotanagpur Division, Bihar State, setting up camp in a tribal village. The programme in Chotanagpur, one of the most seriously affected areas, represented an unusual co-operative effort of groups from the public and private sectors.

that was subject to verification by a supervisor. "Containment books" were designed, printed and distributed in August 1974. One book was used for each outbreak. The name of each person in each of 500 houses surrounding an infected household in a rural area (1000 houses in an urban area) was to be listed in the book and repeat visits made to the village until all persons had been vaccinated and the fact duly registered in the book (Sharma & Grasset, 1975). In a separate section of the book, information regarding each case was recorded.

Three specific standards were also established at this time as indices of the effectiveness of, respectively, surveillance, containment, and outbreak investigation activities. The provision of standards by which a programme in any area could be measured was thought to be helpful in improving the quality of supervision. An indication of the degree of effectiveness of surveillance was the lapse of time between the onset of the first case and the detection of the outbreak. The detection of at least 75% of outbreaks within 14 days of the onset of the first case was felt to be attainable. If adequate containment were performed, all susceptible contacts would be vaccinated and none should develop smallpox once vaccinial immunity had developed—say, after 7–12 days. Assuming that it would take several days to identify and vaccinate susceptible persons, it seemed reasonable to establish a second goal—namely, that no cases should develop more than 17 days after an outbreak was detected. The quality of the investigation of an outbreak was more difficult to measure, but such quantification was considered important because experience had shown that the least well performed part of an investigation was usually the identification of the source of infection. The concept that each individual with smallpox must have been in face-to-face contact with another individual with smallpox just 7–17 days before onset was a surprisingly difficult concept for many to grasp. On investigation forms, many simply listed "sporadic" as the source of infection. To identify the source, however, was vital because often other, as yet undiscovered, outbreaks were unearthed in this manner. Thus, the third goal called for the identification of the source of the outbreak in 90% of outbreaks, a level of success which had been achieved by competent epidemiologists in other areas.

The measurement of progress based on the number of the then existing infected villages and urban *mohallas* (sections of a city) had been initiated in October 1973 in West Bengal and had been introduced in some other states as well, particularly those with a low incidence of smallpox. In June 1974,

The Problem of Beggars

The containment of outbreaks among beggars proved to be an exceptionally difficult problem requiring imaginative and administratively unorthodox solutions. The isolation of beggars with smallpox in their homes was impossible because most were transients. In fact, isolation either in a house or in a hospital was refused because both the beggars and their families were dependent on begging for their livelihood. Even those actively ill with smallpox travelled from village to village shouting for alms, as was their custom. During 1973, a number of instances were documented in which infected beggars had transmitted smallpox to a dozen or more people and had been the source of many widely dispersed outbreaks.

In 1973 an epidemiologist wrote to propose that beggars with smallpox and their families should be given food and lodging until they recovered. The proposal was rejected by WHO regional office administrators and senior Indian staff, who foresaw this as a precedent to providing support to a legion of beggars. Undeterred, Dr Stephen Jones, a free-spirited American epidemiologist, used his imprest account funds to do just this and submitted a bill of 1800 rupees for the hiring of a house, the purchase of rice, a broom and various other supplies to house a family of beggars. Anticipating trouble in explaining the outlay to WHO's finance officer, Dr Grasset and Dr Foege decided to pay the relatively small bill themselves but argued more aggressively for a change in policy. Eventually, the practice was accepted. During succeeding months, hundreds of beggar families with smallpox were supported in this manner and effective containment of the outbreaks was achieved.

uniform definitions for this method of measurement were developed and it was formally adopted throughout India. Any village or *mohalla* in which a case had occurred within the preceding 4 weeks (subsequently extended to 6 weeks) was considered to be the site of a "pending outbreak". This concept recognized the potential for the spread of smallpox from the patient to susceptible contacts throughout the period concerned and the need to check the outbreak repeatedly to ensure that transmission did not continue. A list was kept in each primary health centre and each district (later, each state) showing the name of the infected village or *mohalla*, the date of onset of each case, the date of discovery, the date on which containment began, the source of infection, and the dates on which supervisory personnel had visited it. The outbreak was not removed from the list until the site was visited and searched again, not less than 4 weeks (later, 6 weeks) after the onset of the last case.

As at the end of June 1974, there were 6401 pending outbreaks in 17 states and Delhi Municipal Corporation (Table 15.25).

With additional resources and an increased complement of supervisory personnel, state-wide search and containment programmes continued throughout the summer. Most of the resources were assigned to Assam, Bihar, Uttar Pradesh and West Bengal, in which searches were conducted monthly. In Bihar alone, 35 national and international epidemiologists and more than 100 state epidemiologists and paramedical personnel assisted state, district and local health personnel (Jha & Achari, 1975); in Uttar Pradesh, there were 27 national and international epidemiologists and 19 state surveillance teams (Srivastava & Agarwala, 1975). Most other states conducted one search during this period, although some conducted two. The number of pending outbreaks began to decline sharply, and with fewer outbreaks surveillance teams were able to provide increasingly better supervision of search and containment activities. The quality of both procedures rapidly improved. In addition, the teams devoted more time to visiting markets and schools to inquire about rumours of possible cases. The number of pending outbreaks decreased to 4606 at the end of July and to 3267 at the end of August. The first hopeful note since February was sounded on 26 August in a WHO South-East Asia Smallpox Regional Surveillance Report: "The opportunities for interrupting smallpox transmission in India, Nepal and Bangladesh are better than at any time since the programme started."

By the end of September, there were only 2124 pending outbreaks, of which 1727

Table 15.25. India: pending outbreaks of smallpox at the end of each month, 1974–1975

State or union territory[a]	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June
South													
Andhra Pradesh	12	9	4	1	0	0	0	0	0	0	0	0	0
Karnataka	0	0	0	0	0	0	0	0	0	0	0	0	0
Kerala	0	0	0	0	0	0	0	0	0	0	0	0	0
Maharashtra	19	9	2	1	0	0	0	0	0	0	0	0	0
Orissa	105	46	11	8	4	4	8	2	0	0	0	0	0
Tamil Nadu	1	2	0	0	0	0	0	0	0	0	0	0	0
East													
Assam	173	87	50	64	65	31	19	5	5	8	7	3	1
Manipur	1	2	2	1	0	0	0	0	0	0	0	0	0
Meghalaya	16	7	2	1	3	2	2	7	13	4	4	0	0
Nagaland	11	6	5	2	0	0	0	0	0	0	0	0	0
Sikkim	0	0	0	0	0	0	0	0	0	0	0	0	0
Tripura	0	0	0	0	0	0	0	0	1	1	1	2	1
West													
Delhi	5	5	4	1	0	0	0	0	0	0	0	0	0
Gujarat	1	0	0	0	0	0	0	6	3	3	0	0	0
Haryana	4	4	2	0	0	0	0	0	0	0	0	0	0
Himachal Pradesh	0	0	0	0	0	0	0	0	0	0	0	0	0
Jammu and Kashmir	13	6	9	1	3	1	0	0	0	0	0	0	0
Punjab	6	6	2	1	0	0	0	0	0	0	0	0	0
Rajasthan	1	1	1	1	0	0	0	0	0	0	0	0	0
Central													
Bihar	3 874	3 320	2 697	1 727	759	251	205	110	62	15	4	4	0
Madhya Pradesh	83	29	17	1	1	1	0	1	0	0	0	0	0
Uttar Pradesh	1 640	866	360	284	131	50	45	50	20	3	0	0	0
West Bengal	436	201	99	30	14	3	6	13	9	6	15	12	0
Total	6 401	4 606	3 267	2 124	980	343	285	194	113	40	31	21	2

[a] No outbreaks were recorded in the union territories of Andaman and Nicobar Islands, Arunachal Pradesh, Chandigarh, Dadra and Nagar Haveli, Goa, Daman and Diu, Lakshadweep, Mizoram and Pondicherry.

(81%) were in Bihar (Table 15.25; Fig. 15.23). The north-eastern districts of Purnea and Katihar in Bihar had more than 600 pending outbreaks, but in only 8 other districts were there more than 50. Almost none were to be found in all of southern and western India. In September, 4674 cases were reported, one-tenth the number recorded in May.

The staff were optimistic but still concerned. The analysis of data from previous years indicated that some increase in transmission occurred at the beginning of October, coinciding with an increase in the numbers of persons travelling from place to place to attend festivals and marriages. Thus, there was a heightened concern about the spread of smallpox over greater distances. Moreover, active outbreaks persisted in 50 municipalities which were recognized to be important sites of dissemination to rural areas. Finally, in Assam, the number of pending outbreaks had actually increased from a low of 50 in August to 64 in September; in this state, field operations were greatly hampered by floods, a poor transportation network and a less than adequate health service. Its neighbour, Bangladesh, appeared to pose no threat, since there were only 163 infected villages in the country at the end of September, a competent programme was in place and the numbers of reported cases and outbreaks were declining as rapidly as in India. In Nepal, to the north, only 4 outbreaks were detected in September 1974.

Additional measures were implemented in October to strengthen surveillance and containment. In all urban areas with active outbreaks, a house-to-house search was conducted every 2 weeks. Additional personnel were assigned to work in Assam. Perhaps of greatest importance was the decision to offer throughout India a reward for the notification of a previously unreported outbreak of smallpox in which a case had occurred within the preceding 6 weeks. This, it was hoped, would permit earlier detection of cases and discourage the suppression of reports which, despite all efforts, remained a problem in some areas. In addition, smallpox cases were sometimes hidden by villagers who held

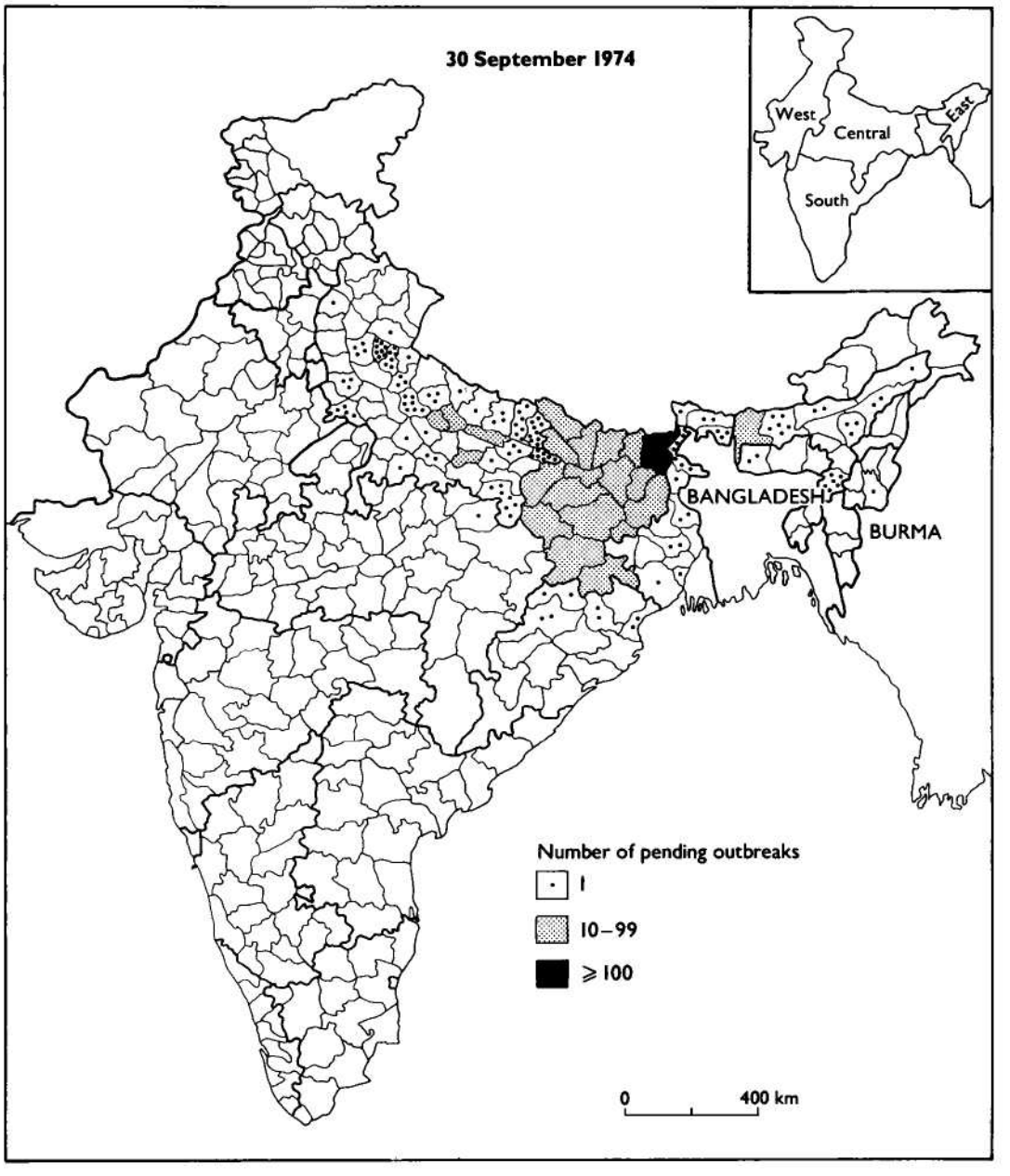


Fig. 15.23. India: number of pending outbreaks of smallpox, by district, as of 30 September 1974.

religious objections to vaccination or feared that patients might be removed to hospital. The offer of a reward had originally been proposed in 1972 in areas with a low incidence of smallpox, but many health officials had been reluctant to adopt the practice, fearing that it would create a precedent with regard to the reporting of cases of other diseases. However, as has previously been described, 5 of the southern states began offering rewards of 10–25 rupees, following the extensive suppression of reports which resulted in the Gulbarga (Mysore) outbreak in 1972. Early in 1974, some other states that had a low incidence or were thought to be smallpox-free also began to offer a reward, which was now increased to 50 rupees. The inducement had not been particularly effective, however, because information about the reward was not widely

Market Searches

Surveys in the traditional weekly markets, held throughout India, were especially useful in detecting cases of smallpox. It was found that 2 searchers could readily question 300–500 market visitors in the course of a working day (Basu & Khodakevich, 1978b) and obtain information about cases in villages 10–20 kilometres distant. It was a technique widely employed by surveillance teams.

Posters showing a smallpox patient and announcing the reward for reporting a case were posted at the entrance to the market and in tea-shops. At each entry point 2 workers were stationed, one of whom asked those entering the market if they knew of cases and which village they were from; the second worker recorded the information. Later, the searchers moved to the tea-shops to continue the questioning. The investigation of all reported or rumoured outbreaks was undertaken the following day.

To assess how effective the market search technique had been, a special study was conducted in a mountainous area of Assam (Khodakevich & Rao, 1978) in January 1976. In a district comprising 695 villages scattered over an area of roughly 15 by 55 kilometres, 7 markets were searched to determine whether outbreaks occurring over the preceding 3 years could be detected. The searchers were health workers who had not been associated with the programme and had no information about previous smallpox in the area. Visitors to the market reported 64 villages as having been infected with smallpox during the preceding 3 years. Investigation revealed that 18 of the villages were in another district, 2 had outbreaks in 1970, 2 had outbreaks of chickenpox, and in 8 others no evidence of outbreaks could be found. The remaining 34 villages in which smallpox was reported to have occurred included all 13 villages which had had outbreaks in 1975, 17 out of 32 of those with outbreaks in 1974 and 4 out of 13 of those with outbreaks in 1973. Although the market searches did not detect all outbreaks, they served to provide a great deal of information at a minimum cost in manpower.

disseminated by the health workers, who wanted to claim the money for themselves. To overcome this problem, it was decided to offer 50 rupees to the person first reporting a previously undiscovered outbreak and 50 rupees to the health worker who received the report.

Containment measures were also strengthened as some surveillance–containment teams, which now had fewer outbreaks to contend with, began to stay in infected villages overnight to ensure that all residents were vaccinated. One or two local inhabitants, termed "watchguards", were hired to stay at each infected house to prevent the patient from leaving and to vaccinate anyone who could not be dissuaded from visiting. Eventually, 4 watchguards were engaged to guard each house with a patient, 2 of them working during the day and 2 at night. This meant that if one watchguard had to absent himself, one would remain on duty. When it was found, in some areas, that visitors avoided the watchguard by entering through a back door, the back entrance was barricaded. Observing that new outbreaks were often found in villages adjacent to those infected, the teams began an increasingly intensive search in a 5-mile (8-kilometre) radius around each infected village.

Information on the means by which outbreaks were actually detected are available for 3798 outbreaks from mid 1973 to mid 1975. The data for the latter half of 1974 and for the first half of 1975 show that an increasing proportion of the outbreaks was being notified by the public and a lesser proportion was detected by periodic search (Table 15.26). In the non-endemic states, notification by the public played a more important role, the proportion of outbreaks so notified increasing from 15% in the first 6 months of 1974 to 29% in the second 6 months and to 36% in 1975.

The outbreaks were detected increasingly earlier after the onset of the first case (Table 15.27), although the standard which called for 75% to be detected within 14 days was never reached. The outbreaks persisted for a shorter time (Table 15.28) but in some of them cases continued to be found more than a month after detection. With earlier detection

Table 15.26. India: methods of detecting outbreaks of smallpox, 1973–1975

Period	Number of outbreaks	Methods of detection							
		Public reports		Regular house-to-house search		Fields visits of health staff		Others[a]	
		Number	%	Number	%	Number	%	Number	%
July–Dec. 1973	457	12	2.6	150	32.8	286	62.6	9	2.0
Jan.–June 1974	2 865	201	7.5	1 729	64.4	742	27.6	13	0.5
July–Dec. 1974	343	33	9.6	160	46.6	147	42.8	3	0.9
Jan.–June 1975	133	15	11.2	57	42.9	39	29.3	22	16.5

[a] Market searches, special searches, cross-notification.

Table 15.27. India: interval between onset of outbreaks of smallpox and their detection, 1973–1975

Period	Number of outbreaks	Interval									
		0–7 days		8–14 days		15–28 days		29–56 days		>56 days	
		Number	%	Number	%	Number	%	Number	%	Number	%
July–Dec. 1973	1 293	303	23	186	14	252	19	230	18	322	25
Jan.–June 1974	6 535	2 170	33	1 724	26	1 605	25	782	12	254	4
July–Dec. 1974	1 369	478	35	248	18	301	22	255	19	87	6
Jan.–June 1975	226	104	46	48	21	45	20	27	12	2	1

Table 15.28. India: interval between onset of first and last case of smallpox, 1973–1975

Period	Number of outbreaks	Interval					
		<1 month		1–2 months		>2 months	
		Number	%	Number	%	Number	%
July–Dec. 1973	1 460	1 065	73	192	13	203	14
Jan.–June 1974	6 559	4 980	76	1 025	16	554	8
July–Dec. 1974	1 234	1 027	83	151	12	55	4
Jan.–June 1975	230	199	87	25	11	6	3

and better containment, the outbreaks, as might be expected, were less extensive (Table 15.29).

Assessment of the ever-more-thorough searches was modified to determine the proportion of villagers who were aware of the reward for reporting cases. It was assumed that if the existence of the reward were generally known, cases would not be hidden for long. Personnel searching for cases were instructed to convey the fact of its existence to all the villagers. Radio, posters, leaflets, rickshaws with loudspeakers and announcements at weekly local markets were also used as a means of information.

During the autumn, the number of pending outbreaks fell steadily, from 2124 at the end of September to 980 at the end of October and to 343 at the end of November (Fig. 15.24), but then the rate of decline slowed considerably. Almost as many new outbreaks were being added to the list as were being removed. The winter season of more rapid transmission had begun. The numbers of outbreaks and cases were at a record low, but, if smallpox transmission was to be interrupted, even more rigorous methods of case detection and containment would be required.

Table 15.29. India: distribution of outbreaks of smallpox by size and year, 1973–1975

Number of cases in outbreak	1973		1974		1975	
	Number	%	Number	%	Number	%
1	34	19	659	33	86	40
2–4	44	25	643	32	86	40
5–9	41	23	348	17	26	12
10–19	31	17	229	11	12	6
20–49	28	16	115	6	5	2
≥50	1	1	19	1	1	1
Total	179	100	2 103	100	216	100

Concern about the programme's progress suddenly turned to alarm in mid-December

Status of the Programme in Early December 1974

Memorandum, dated 9 December 1974, from the Chief of the WHO Smallpox Eradication unit to all smallpox eradication staff:

"The autumn saga of 1974 has been marked by weeks of unexpectedly rapid decreases in the number of pending outbreaks in Asia interspersed with weeks when there has been little or no decline. At present, we seem to be again in the latter phase. Does this signal the beginning of a phase where seasonally increased rates of transmission overbalance our capability to contain the outbreaks *or* does it represent but a pause in the countdown as we regroup to redeploy forces and to tighten up containment procedures and so recommence the countdown? Unquestionably, a greater effort is required during the winter months to ensure containment of each outbreak, but the task can be accomplished.

"With search activities now reasonably well developed in most districts and with market searches and the system of rewards serving to assure discovery of outbreaks missed in search, it seems to me that now is the time to deal far more rigorously with containment measures. In many areas ... staff have not dealt with containment as rigorously as is now required. This is not surprising. During the summer and early autumn months, further spread of smallpox occurred only infrequently even when containment measures were less than optimal. Inevitably, emphasis shifted to improving the search procedures, sometimes perhaps at the expense of the arduous and meticulous work required to assure 100% containment. With increased rates of transmission and more population movement, containment procedures which were effective in October are no longer so.

"At this stage, and with the comparatively few outbreaks we have, *every patient* must be subjected to 24-hour guard and, as required, food provided to the families to provide further incentive for them to stay put. If the guard is fully effective, every subsequent contact will be protected by vaccination. But *frequent* supervision by epidemiologists and senior staff is mandatory if the system is to work. Then begins the now necessary but arduous task of tracing all contacts of the patient from the time of onset of rash. This procedure is in effect in some areas but, as of the time of my visit two weeks ago, it was not in effect everywhere.

"Most important now is for each epidemiologist to consider each new outbreak as being indicative of a possible failure in the system. The question for each outbreak must be asked—'Why did this outbreak occur and what should be done to prevent a repetition of the episode?'"

1974 as major epidemics unexpectedly began in Bangladesh. Catastrophic floods, the worst in 20 years, had swept the northern districts of Bangladesh in August and September and, with the subsequent famine, tens of thousands of refugees migrated to other parts of the country. In December, smallpox began spreading rapidly and once again infected the major cities. The most heavily affected areas were along the northern Bangladeshi–Indian frontier and because of frequent travel across the border, numerous importations were to be anticipated. Of particular concern were the eastern states of India, in which the health services and the smallpox eradication programme itself were the least able to cope.

Realization that a difficult spring might lie ahead was soon followed by the ominous discovery of a cluster of outbreaks at a major pilgrimage site of the Jain religion about 85 kilometres from Patna, the capital of Bihar (Jha & Achari, 1975). The largest outbreak was detected in December 1974 at Puri village, in which the founder of the Jains had died 2500 years earlier. Forty households were infected at the height of the pilgrimage season. Complicating the problem was resistance to vaccination, common among Jains. A special appeal was made to the principal religious leader, who agreed, reluctantly, to recommend vaccination. The entire village was quarantined by the Bihar military police. Twenty-four-hour watchguards were posted at the houses of infected persons and at key areas in the village. A community kitchen was set up to feed patients so they would not have to leave their homes for food. Pilgrims were not allowed to enter sacred pilgrimage

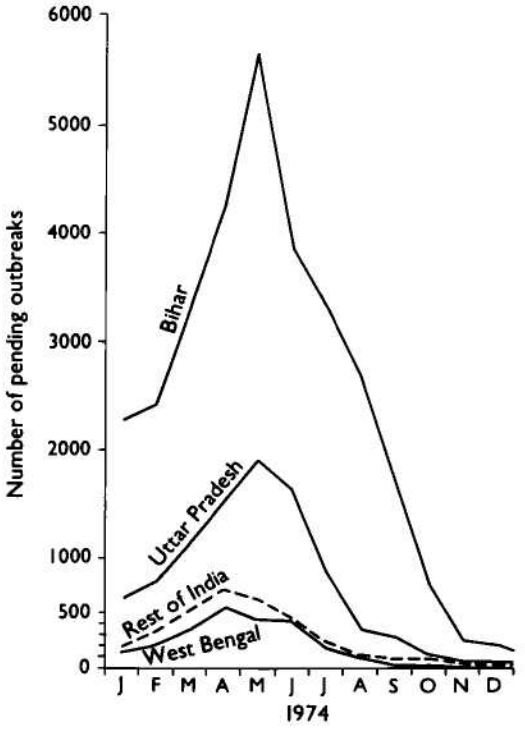


Fig. 15.24. Bihar State, Uttar Pradesh State, West Bengal State and the rest of India: number of pending outbreaks of smallpox at the end of each month, by month, 1974.

areas until they had been vaccinated. Although smallpox spread to 5 adjacent villages, the outbreak in Puri was finally controlled by the end of February 1975.

Elsewhere in the district, the number of outbreaks had increased from 16 to 75. Assessment revealed poorly conducted search operations and inadequate containment. Emergency measures were introduced. Whenever an outbreak was discovered, 20–25 vaccinators were dispatched to the infected village; containment vaccination was completed within 48 hours; 24-hour watchguards were posted at every infected household; and food was brought in to ensure household quarantine. Entire villages were cordoned off when necessary. Instead of a few vaccinators, dozens were assigned to each newly discovered infected village and camped there until no active case remained. In all, 102 new outbreaks were discovered in Bihar in January 1975.

"Operation—Smallpox Zero", January 1975

With smallpox present in only 285 of the more than 575 000 villages of India at the end

Problems in Containment: a Report by a Supervisor in Bihar, May 1975

"We have the misfortune to have to inform you of a new case of smallpox in the Painathi outbreak, a 4-month-old unvaccinated male with onset of rash on 30 April. The household is only 10 metres from a household where a severe case occurred on 13 April.

"The patient and his mother left Painathi on 29 March, 2 days before containment began. The mother was enumerated but the existence of a child was not made known. They returned on 14 April but their presence was concealed by the father. Searchers went daily to each house in the village to vaccinate and to inquire about fever and rash. Dr Khan and Dr Briedert personally visited this house to find out if all the vaccinations were successful and if this woman had returned. The father of the child, however, lied to them.

"The family had been resistant and uncooperative from the start. After enumeration, vaccination was possible only when we climbed over the compound walls and forcibly inoculated each family member. After a rumour reached Dr Khan, who had been staying in the village, he had to use a trick to gain entrance to the house. He asked for a glass of water and this was denied. He knew by custom that they had a case of smallpox inside the house because nothing can be given when a case of smallpox is in the house of a member of this religious sect.

"Dr Briedert is now staying *inside* the infected house. A room-by-room search has been done and will continue daily. All visitors have been traced—all had been previously vaccinated. The mother was vaccinated on 2 May. She has a primary scar and we can only hope that she will not develop into a case. We are nonetheless isolating her and keeping her under close observation for the next 14 days."

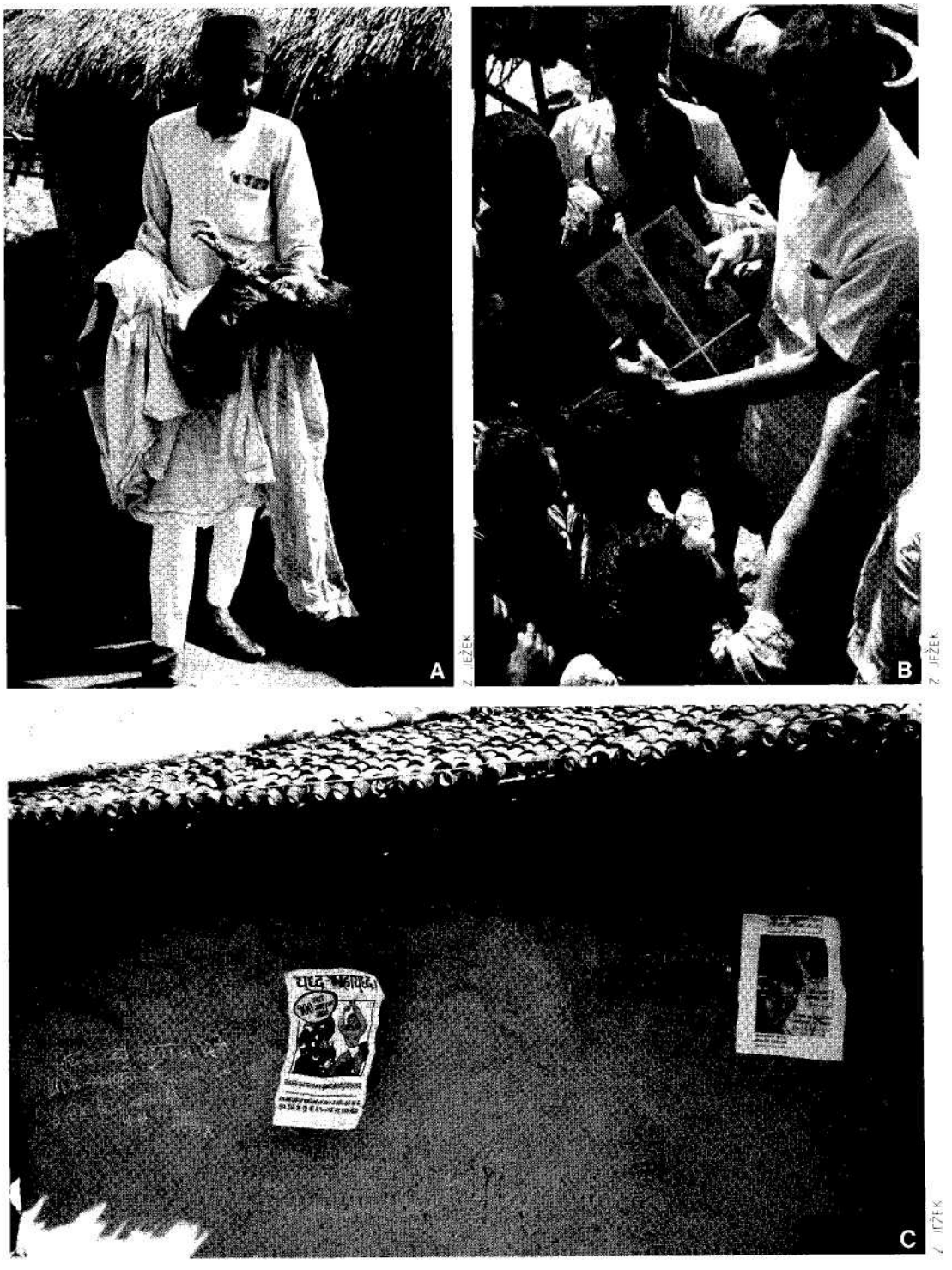


Plate 15.16. The search for smallpox cases intensified throughout 1975 as efforts were made to detect all cases of fever accompanied by rash. **A**: A village headman brings a child to smallpox eradication staff for confirmation of diagnosis. **B**: A search worker shows the WHO smallpox recognition card to children. **C**: Posters and writing on a wall advertise a reward of 100 rupees to anyone who detects a case of smallpox.

of December 1974 and with reasonable confidence that there were few undetected outbreaks, it appeared that the elimination of smallpox was at hand. However, from the experience of the past year in Bihar, it was clear that smallpox could spread rapidly in this densely populated area during the winter and early spring. Analysis of the experience in the autumn of 1974 showed that deficiencies in containment were primarily responsible for the failure to stop outbreaks. Vaccination of the population of affected villages was not as rapid as it might have been, visitors to the villages were often not vaccinated and some villages were declared free of smallpox without a thorough follow-up search. Although searches were conducted within a 5-mile (8-kilometre) radius of infected villages, some outbreaks traced to those villages were found to occur at distances of up to 16 kilometres.

At the end of December, new instructions were issued by the government entitled "Operation—Smallpox Zero". The following passages are extracts from the instructions:

"With the outbreaks so few in number, each outbreak must now be dealt with as an *absolute* emergency with maximum mobilization of staff and volunteers. As much concern should be directed to each outbreak as would be directed to control an outbreak in a non-endemic country such as in Europe. *Never* should a case occur more than 21 days after discovery of an outbreak.

"With the very small number of outbreaks present and with fully effective containment, smallpox transmission should be stopped in India in not more than 6–8 weeks. An all-India, all-out effort to achieve this objective will commence immediately and at all levels of the programme. These activities will be conducted under the code name 'Operation—Smallpox Zero' with the objective that no case of smallpox would occur after February.

"*PROCEDURES*

"1.0 A special Central command comprised of senior experienced Government and WHO staff will visit every new outbreak detected after 1 January and will revisit every outbreak in which a case is discovered more than 21 days after its discovery to ensure that every possible measure is being taken. These will supplement, not replace, other supervisory visits. To facilitate this, all new confirmed outbreaks must be reported immediately by cable to the State Programme Officer and to New Delhi. Any case occurring more than 21 days after discovery of an outbreak must similarly be reported by cable.

"2.0 Every outbreak must now be dealt with rapidly and with a massive containment effort. Instead of three or four workers, the containment teams should consist of *15 to 20 workers or more*, headed by the District Medical Officer of Health assisted by a national or WHO epidemiologist. In urban areas, this number may be several times greater. *Vaccination in an infected village/mohalla must be essentially completed within two or at most three days.* Three or four workers must camp in the village/mohalla until all scabs have separated from the last case. Two watchguard-vaccinators must be assigned to each infected house to maintain a 12-hour watch during the day while a second pair maintains a 12-hour watch at night. Watchguards will be responsible for (1) vaccinating all persons visiting the houses of smallpox patients; (2) identifying all household contacts who leave to go to other areas; (3) maintaining isolation of smallpox cases; and (4) maintaining an hour-by-hour log book record of activities and of movement of people in and out of the households. Food, necessary medicines and housing may be supplied to the family of an infected patient on a daily basis to ensure cooperation and isolation. Smallpox containment field books with complete enumeration of the village/mohalla must be completed on each outbreak.

A typical containment team might include:

1. 4 watchguard-vaccinators for each infected house
2. 8 vaccinators of which 4 should camp each night in the village
3. 2 motivation workers (village-level workers who know the village/mohalla and are respected by the villagers)
4. 1 supervisor and 2 vaccinators to trace household contacts who have gone to other areas
5. 3 supervisors
6. 1 containment team leader.

"3.0 House-to-house search will be made in a 10-mile [16-kilometre] radius around an outbreak as well as in high-risk areas which may be outside the 10-mile radius. In the urban areas the surrounding mohallas will be searched in a similar manner. This will be followed in two weeks by a second house-to-house search within a five-mile [8-kilometre] radius to find cases which might have been in the incubation period during the first search.

"4.0 In case of a death, the vaccinator will accompany the remains to be certain that the body is properly disposed of and that all garments are buried. All attending the funeral will be vaccinated, a register of participants and their addresses will be prepared and all villages from which they came placed under surveillance.

"5.0 After 1 January, a laboratory specimen from one or two cases in each new outbreak will be collected."

It was decided that the periodic routine search programmes would consist of house-

to-house visits, whereas previously searchers had checked only a sample of houses in each village. The reward for reporting a case was increased from 50 rupees to 100 rupees. Each suspected case—i.e., one with a rash and fever—was to be recorded in a "rumour register", which was established at every primary health centre. Each patient was to be visited immediately by the local health officer and the diagnosis confirmed by an epidemiologist. If the diagnosis was uncertain, it was to be considered smallpox and watchguards were to be posted. By experience, it was found that good performance on the part of watchguards could be ensured by the simple expedient of not paying them until they were relieved of duty. If, at any time, a watchguard was not found on duty, all 4 were dismissed without pay and new watchguards were recruited. Containment vaccination was to include all persons within a 1-mile (1.6-kilometre) radius of the outbreak. In all, this meant vaccinating some 4000–5000 people in rural areas and 80 000 in urban areas (Sharma & Grasset, 1975). Search throughout an area with a 10-mile (16-kilometre) radius, performed by locally recruited and trained staff, usually encompassed 300–600 villages. The costs of a typical containment operation in 1975 were estimated by Ježek to be about US$2700 (Table 15.30).

Investigations into the source of the outbreak were intensively pursued by national and international epidemiologists, but now, instead of notifying neighbouring states or districts of the existence of a suspected source, they themselves proceeded to the locality. This ensured that the sources would not be missed because of difficulties with telegraphic communication or confusion due to information being received from illiterate villagers and the consequent need to spell village names phonetically.

To guard against importations from Bangladesh, special surveillance teams were assigned and special searches conducted in Muslim Bengali areas and communities in India. Special attention was given to Calcutta, in which repeated night searches were made among the 48 000 street dwellers (Spring, 1975).

Table 15.30. India: estimated manpower employed and costs of a typical containment operation, 1975

	Rupees (Rs.)
1. Substantive staff	
Epidemiologist, 21 days at Rs. 100 per day	2 100
Junior medical officer, 42 days at Rs. 35–50 per day	1 764
Paramedical assistant, 42 days at Rs. 15–30 per day	924
Driver, 102 days at Rs. 10–15 per day	1 224
Total:	6 012
2. Additional (temporary) staff	
Watchguards (assume 2 infected houses): 8 workers, 42 days at Rs. 5 per day	1 680
Search workers to search 10-mile radius (assume 500 villages), 300 search-days at Rs. 5 per day[a]	1 500
Search workers to do repeat search of 10-mile radius	1 500
Vaccinators to vaccinate the village population (assume 1000 population): 20 vaccinators, 5 days at Rs. 5 per day	500
Vaccinators to vaccinate population in a 1-mile radius: 20 vaccinators, 15 days at Rs. 5 per day	1 500
Supervision (at 1 supervisor to 5 worker-days)	
(*a*) for search of 10-mile radius, 60 supervisor-days at Rs. 10 per day	600
(*b*) for repeat search	600
(*c*) for watchguards, 1 supervisor, 42 days at Rs. 100 per day	420
(*d*) for vaccinators of village, 4 supervisors, 5 days at Rs. 40 per day	200
(*e*) for vaccination of population in a 1-mile radius, 4 supervisors, 15 days at Rs. 40 per day	600
Total:	9 100
3. Petrol	
Usually, each new outbreak was attended by several teams of jeeps for various periods of time. The jeeps were used for supervision, search assessment and follow-up.	
Week 1: 4 jeeps or 28 jeep-days	
Weeks 2–3: 3 jeeps or 42 jeep-days	
Weeks 4–5: 2 jeeps or 28 jeep-days	
Week 6: 1 jeep or 7 jeep-days	
105 jeep-days	
Total:	9 450
Total cost:	24 562 (US$2 730)

[a] Based on petrol costs averaging Rs. 90 per day.

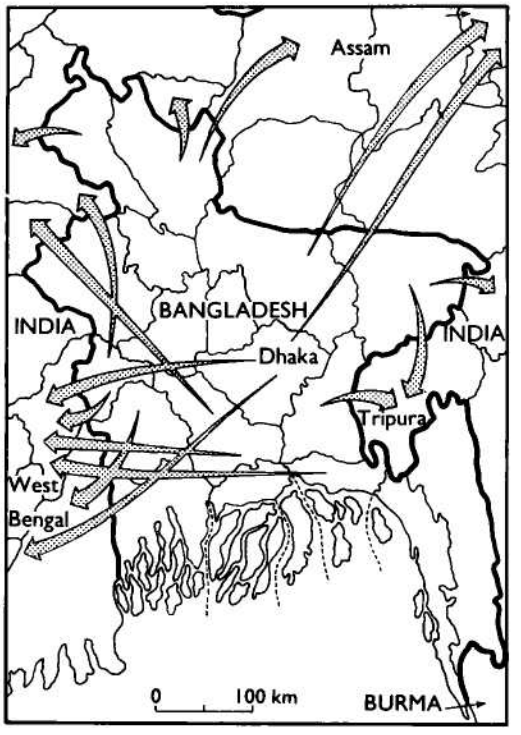


Fig. 15.25. Importations of smallpox from Bangladesh to India, 1975.

"Operation—Smallpox Zero", begun in January 1975, proved to be most successful. From November to December 1974, the number of pending outbreaks had decreased from 343 to 285 (17%); in January, to 194 (32%); and in February, to 113 (42%). As had been feared, cases were imported from Bangladesh, 30 importations being detected in West Bengal, Assam and Tripura (Fig. 15.25). Two-thirds were detected within 2 weeks of the onset of illness in the first case and only 8 additional outbreaks occurred as a result of further spread.

In all, only 308 outbreaks and 1436 cases were detected in India after 1 January 1975 (Tables 15.31 and 15.32). All were in the eastern part of India except for 10 in the far western Kutch desert of Gujarat, introduced by migrants probably infected in Bihar.

In April, 115 000 health workers undertook a week-long, house-to-house search throughout the whole of India. Independent assessment of some 5% of villages showed that 85%–96% of all villages in the various states had been searched. Among 574 517 persons interviewed, 61% knew about the reward for reporting a case and knew the amount of the reward. Only a few

Table 15.31. India: number of reported cases of smallpox, by state and by month, 1975

State[a]	Jan.	Feb.	March	Apr.	May	June	July–Dec.	Total
Assam	29	27	13	18	1	0	0	88
Bihar	654	111	28	25	21	0	0	839
Gujarat	8	2	4	0	2	0	0	16
Meghalaya	25	11	21	4	0	0	0	61
Orissa	0	1	5	0	0	0	0	6
Tripura	0	1	0	1	7	0	0	9
Uttar Pradesh	243	45	5	0	0	0	0	293
West Bengal	51	14	8	33	16	2[b]	0	124
Total	1 010	212	84	81	47	2[b]	0	1 436

[a] Nil reports were received from other states and all the union territories.
[b] The date of onset of the last case was 26 May (cases are listed by month of report).

Table 15.32. India: newly detected outbreaks of smallpox by state and by month, 1975[a]

State	Jan.	Feb.	March	Apr.	May	June–Dec.	Total
Assam	4	3	8	5	1	0	21
Bihar	102	41	9	3	1	0	156
Gujarat	6	0	2	0	2	0	10
Meghalaya	7	10	2	3	0	0	22
Orissa	1	0	0	0	0	0	1
Tripura	0	1	0	1	2	0	4
Uttar Pradesh	44	4	1	0	0	0	49
West Bengal	14	4	9	13	5	0	45
Total	178	63	31	25	11	0	308

[a] Outbreaks were reported immediately by telegraph or telephone; case reports (Table 15.31) were submitted through routine notification channels and were somewhat delayed in receipt.

outbreaks were found, all of which had resulted from importations. Smallpox had been virtually eliminated during the season of most rapid transmission. In May, the last cases and outbreaks in India were discovered.

The Last Case in India, May 1975

As in many other countries, so in India the last case presented some unusual features (Ježek et al., 1978a). Saiban Bibi, a 30-year-old homeless Bangladeshi beggar, developed a rash while living on the Karimganj railway station platform in Assam, where she was begging for food. She had contracted smallpox from a patient in Sylhet District, Bangladesh. On 26 May, she went to the Civil Hospital in Karimganj, which forthwith notified the District Health Officer. Accompanied by a WHO epidemiologist and the state surveillance team, he immediately went to investigate.

The situation was alarming. For the first 4 days of illness, the patient had lived on the platform of the railway station, the gateway to the states of Assam and Tripura and the union territory of Mizoram. Between 22 and 26 May, 9 trains had stopped at the station and 4535 railway tickets had been issued to 68 different towns and cities. A programme was immediately launched to search and vaccinate in the city wards in which the railway station and the Civil Hospital were situated. Later, containment activities extended to the whole town, as well as to all villages visited by the patient since 21 May. Railway authorities were instructed to intensify surveillance activities in and around the railway stations and railway colonies. All district health authorities in Assam and neighbouring states through which the railway passed were asked to initiate intensive searches during the subsequent 14 days. Special searches were conducted in all villages within 10 miles (16 kilometres) of the district border with Bangladesh.

The patient was isolated and 4 watchguards were stationed in the isolation ward for round-the-clock duty. All patients, visitors and hospital staff, together with their relatives, were enumerated and vaccinated. The hospital was closed to visitors and the discharge of patients was stopped. One watchguard was placed at the railway station to carry out surveillance and vaccination.

Three border checkposts were established and all incoming and outgoing travellers were checked and vaccinated. All border security forces and police outposts were alerted to look for possible cases.

Surprisingly, despite the time of year and the many persons who had been in contact with the patient, no further cases were found.

India Celebrates Independence Day and Freedom from Smallpox, August 1975

Six weeks passed after the onset of illness in the last patient and the last outbreak was deleted from the list of pending outbreaks. On 1 July, the reward for reporting a case was increased to 1000 rupees (US$125), the equivalent of 4 months' salary for an Indian labourer. This was done with some trepidation, since it was feared that unscrupulous persons might smuggle smallpox cases from Bangladesh to claim the reward. Indeed, on one occasion this did happen, but the ruse was readily detected. With a reward of this magnitude, thousands of patients with rash and fever were reported to the health authorities. Each was investigated; none proved to have smallpox.

On 15 August 1975—India's Independence Day—the government held a special celebration honouring India's freedom from smallpox, which was attended by the Director-General of WHO.

Less than 3 months had elapsed since the onset of the last case, and with smallpox still present in Bangladesh the staff were understandably apprehensive that at the last moment another focus might be found. The search continued, but an unexpected event of quite another type occurred. On the night of 15 August, the President of Bangladesh was assassinated. The government closed the airports and sealed the borders—to the extent that this was possible. It was feared that there might be yet another mass exodus of refugees.

An emergency surveillance programme was immediately put into operation, focusing on Bengali-speaking areas. Possible migration routes were identified, dozens of surveillance posts were set up at border crossings, special searches were conducted in designated high-risk areas and surveillance was intensified in Calcutta. Happily, the refugees were few and no further importations occurred.

On 16 October 1975, the last case of smallpox occurred in Bangladesh and the 2-year search began to confirm eradication throughout Asia.

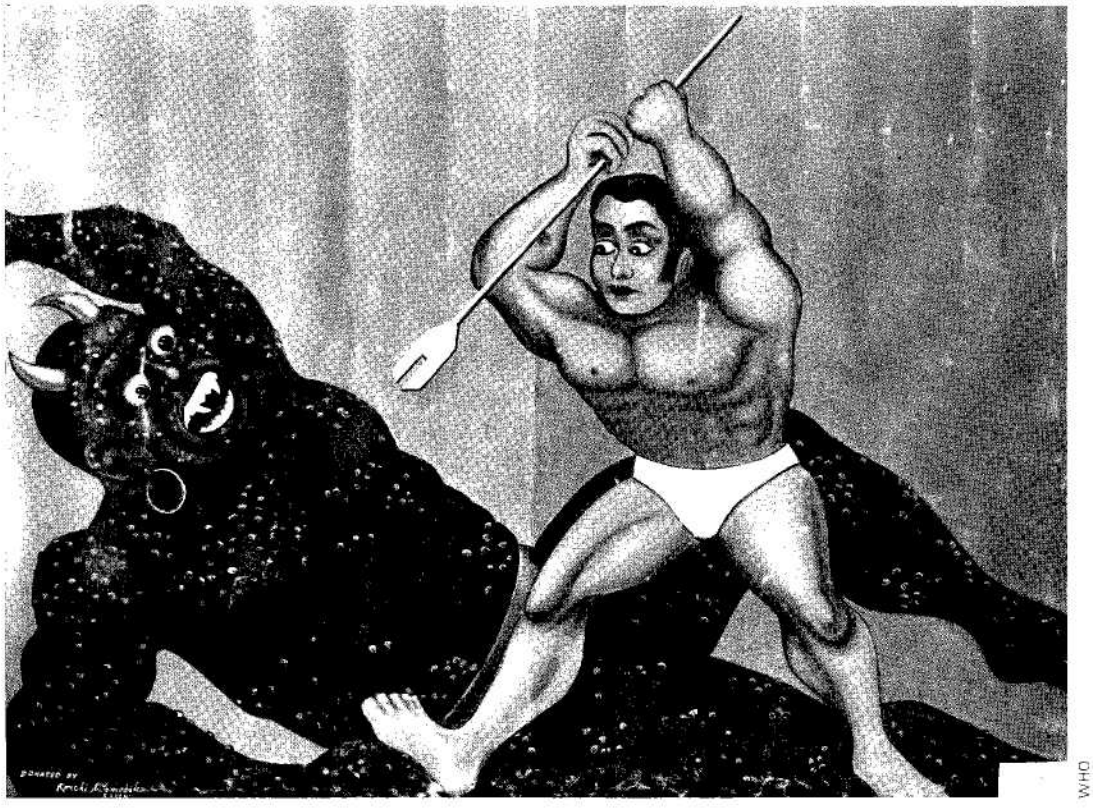
Why the Smallpox Eradication Programme Succeeded

Two papers have been published by members of the smallpox eradication staff which comment on distinctive features of the smallpox eradication programme in India that were crucial to its success. Extracts are given below:

"The strategy used and the manpower and other resources provided ... greatly contributed to the rapid success of the programme; but without the passion given to the planning and implementation of the programme by the workers, achievement would not have been possible. Jawahar Lal Nehru once said 'Planning would be meaningless unless behind the plan there was a passion—passion with a tinge of anger at delays, anger at anybody not doing his part, anger at not achieving where achievement is possible'. The national and WHO staff have fought with passion the battle against smallpox... Hundreds of men and women—nationals and internationals—have worked up to 18 hours a day for seven days a week in the belief of an ideal which they have put above their personal happiness, their family life, their career and their health. The central level staff both of the WHO and the Government of India have spent on an average three weeks a month working in the field throughout the country to train, motivate, encourage the local staff. During the 1974 summer epidemic of smallpox in Bihar and [Uttar Pradesh], a number of WHO, central and state officers were publicly laughed at for having predicted that their states and the country would be free of smallpox in less than a year ... Men and women from different states in India and from many countries of the world put aside their racial, national, religious or social prejudices and bore together all the difficulties and hazards. Many took risks in putting aside conservative regulations, red tape and antiquated technical methodologies, when these threatened to delay their task or obstruct the path to success. The toughest of men and women on many occasions were on the verge of discouragement—from physical tiredness and mental frustration, when having to cope with hundreds of infected villages in their area of responsibility. They persevered, waiting days, weeks, sometimes months, until it was possible to send them more men, better vehicles, funds for petrol, etc. In the smallpox offices in New Delhi and also in the state, district and block headquarters, medical officers, administrators and secretarial staff worked most of the days far into the night, over the weekends and public holidays so as to make sure that those in the field received the necessary support. However, even during the most difficult stages of the programme, men and women in the field and offices discovered like Rabindra Nath Tagore that they 'acted and behold duty was joy'." (Sharma & Grasset, 1975.)

"The decentralisation of authority to implement the strategy to the district health authorities and epidemiologists who were responsible for proper utilisation of available resources resulted in the early detection and effective containment of large numbers of disease foci in the shortest possible time and the consequent quick interruption of transmission. If one considers that ... India ... [was] spending over 40 million rupees a year for the past ten years on NSEP and [that an] additional amount of about Rs. 20 million each [year was being spent by WHO] during the campaign years 1973–74 and 1974–75 ... it becomes apparent that it has not been the quantum of money spent but the manner of doing it which made all the difference between success and failure. Relative freedom at district levels to take on-the-spot decisions to spend this additional amount ... greatly contributed to the realisation of smallpox free status. Administrative and operational restraints in implementing the strategy were also minimal.

"All the national health programmes have built-in evaluation methods. The interval between occurrence of a defect/problem and its detection and the interval between the detection and correction has always been considerable ... In this smallpox campaign the continuous monitoring of the smallpox status, feedback from the field staff and the authority for taking on-the-spot decisions regarding fiscal, administrative and technical matters have narrowed down the unknown and the unsolved problems to the minimum." (Dutta et al., 1975.)



WHO

Plate 15.17. A wall-sized poster, in the style of a cinema advertisement, depicts a hero slaying the smallpox demon with a bifurcated needle. This poster, also used in smaller sizes, was displayed widely in India to promote the reward for reporting a case of smallpox.

Morbidity and Mortality Data

Information regarding the age, sex, vaccination status and survival or death of the patient was obtained for all cases in India. However, data were tabulated nationally for only a proportion of the total for the years 1974–1975 (Basu et al., 1979). These data were obtained from 4 high-incidence states and 13 low-incidence states and union territories, although most of the cases were from the former group. The age distribution of cases and case-fatality rates were similar to those observed elsewhere in the Asian subcontinent (Table 15.33).

Data are available for 23 546 of the 189 439 cases which occurred in 1974–1975. In all, 31% occurred in individuals less than 5 years of age, 40% in those aged 5–14 years, and 29% in those aged 15 years and over. The disease was equally prevalent among males and females.

A similar distribution of cases by age and sex was observed in all states with a high incidence. Imported cases in smallpox-free states, however, occurred predominantly in males (64.6%) in the older age groups, 18.7% being in men aged 50 years and over. This was attributed to the occurrence of many cases among migrant labourers and pilgrims, a much larger proportion of whom were adult males.

Data regarding the vaccination status of 14 463 cases from the same 17 states and union territories reveal that two-thirds of the persons concerned were unvaccinated (Table 15.34). Patients were classified as "unvaccinated" if they had no vaccination scar (regardless of whether they claimed to have been vaccinated) or if they had been vaccinated during the incubation period of the disease, too late to prevent infection.

The proportion of cases among individuals with an apparent vaccination scar was markedly higher than in other countries. This is explained by the frequent occurrence of vaccination-like scars associated with the use of rotary lancets in which secondary bacterial

Table 15.33. India: number of reported cases of and deaths from smallpox and case-fatality rate in 17 states and union territories, by age group, 1974–1975[a,b]

Age group (years)	Cases		Deaths		Case-fatality rate (%)
	Number	%	Number	%	
<1	1 373	5.8	597	14.5	43.5
1–4	5 867	24.9	1 436	35.0	24.5
5–9	5 875	24.9	783	19.0	13.3
10–14	3 626	15.5	308	7.5	8.5
15–19	1 916	8.2	124	3.1	6.5
20–29	2 462	10.6	369	9.1	14.9
30–39	1 320	5.6	192	4.7	14.4
40–49	695	2.7	140	3.4	20.1
⩾50	412	1.8	154	3.7	37.4
Total	23 546	100.0	4 103	100.0	17.4

[a] From Basu et al. (1979).
[b] States with a high incidence: Bihar, Madhya Pradesh, Uttar Pradesh and West Bengal. Others: Andhra Pradesh, Assam, Gujarat, Haryana, Jammu and Kashmir, Karnataka, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, and the union territory of Delhi.

Table 15.34. India: vaccination status of cases of smallpox in 17 states and union territories, by age group, 1974–1975

Age group (years)	Vaccinated		Unvaccinated		Total
	Number	%	Number	%	
0–4	506	12.1	3 671	87.9	4 177
5–9	1 008	26.7	2 767	73.3	3 775
10–14	933	41.0	1 343	59.0	2 276
15–19	490	41.8	683	58.2	1 173
20–29	725	49.5	739	50.5	1 464
30–39	549	65.2	293	34.8	842
40–49	281	71.9	110	28.1	391
⩾50	275	75.3	90	24.7	365
Total	4 767	32.9	9 696	67.0	14 463

infections occurred but vaccinia virus did not grow. Most of the cases among "vaccinated" children under 5 years of age occurred in Bihar and Madhya Pradesh, in which, as late as 1973, rotary lancets were still being used in some areas, especially the large municipalities. In Andhra Pradesh, in which the use of rotary lancets was abandoned in 1969, only 15.4% of cases occurred among those with what appeared to be a vaccination scar.

Case-fatality rates in India varied from 21% to 31% during 1950–1967 but for most years they were in the range of 25–30%. During the course of the eradication programme, the case-fatality rate dropped steadily, from 31.2% in 1967 to 16.6% in 1974 and to 12.3% in 1975 (Fig. 15.26). The decline is accounted for by an increasing completeness of the notification of cases. Initially, most cases and deaths were reported from infectious disease hospitals, to which the more seriously ill were taken and which recorded high case-fatality rates. As time progressed, differences between case-fatality rates in the various states narrowed considerably. Moreover, a much higher proportion of cases in otherwise smallpox-free areas was found among older children and adults, who experienced a lower case-fatality rate than did young children. Data for 23 546 cases that occurred in 1974–1975 show an overall case-fatality rate of 17.4%, but among infants under 1 year of age the rate was 43.5% whereas it was only 6.5% among the 15–19-year-olds. Although wide variations in case-fatality rates were observed in different epidemics, these variations were considered to be due to differences in the age distribution of the cases, the nutritional status of patients, and the history of previous vaccination.

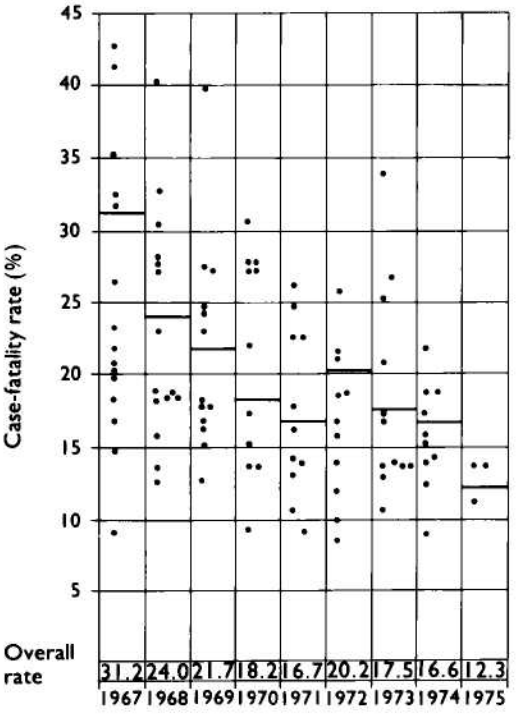


Fig. 15.26. Case-fatality rates for India and the states of Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal, by year, 1967–1975. Each dot represents the case-fatality rate in a state in a year. For each year rates are plotted only for the states that recorded at least 100 cases that year. The bold lines denote the overall rate for India in the year shown.

NEPAL

Introduction

Epidemiologically, Nepal was a mountainous extension of the Indian states of Bihar and central and eastern Uttar Pradesh, but its programme differed significantly from that in India. Of the country's 10.8 million population (in 1967), 37% lived in the Terai, a northern strip of the broad Ganges river plain (see Fig. 15.1), which in Nepal was about 25–35 kilometres wide; another 53% lived in the adjacent Middle Hills area, which ranged from 30 to 50 kilometres in width. Most of Nepal's population thus lived within some 80 kilometres of the border with India and the majority were Hindu. Many had relatives in adjacent areas of India, and travellers and migrant labourers moved freely across the border. Roads were few, communications were difficult and the health services and other governmental structures were in an early phase of development.

In 1962, a WHO nurse working in Nepal assisted in the development of a pilot mass vaccination campaign in the Kathmandu valley, comprising 3 of Nepal's 75 districts with a population of 500 000. In 1968, the campaign was extended to other districts and by 1973 it included the entire country. Little was done to develop a reporting system until 1971. Data prior to this time represent only a partial enumeration of cases in the Kathmandu valley.

Strategically, the programme in Nepal was initially not of high priority in the global strategy because eradication there depended on the progress of the campaign in India, particularly in Bihar and Uttar Pradesh. Moreover, the mainly mountainous terrain, the predominantly rural population and the poor communications between villages in Nepal suggested that smallpox transmission could not be long sustained in most of the country. Since the population of the Terai was only about 4 million—the equivalent of 2 districts of India—it was expected that the interruption of transmission in that area and in the country as a whole would not constitute a major problem once smallpox had been controlled in India.

Because the health structure in Nepal was rudimentary and vaccine was available to only a small proportion of the population, additional WHO support was provided from 1968. The eradication programme was intended to make vaccination more widely available initially in the most populous areas along the border with India. Three years later, a plan was implemented to extend reporting and surveillance–containment measures progressively throughout the 75 districts. Progress in achieving these goals was remarkably rapid: by 1972 each outbreak was being investigated and contained and its source identified. Continuing transmission was, in fact, largely stopped in that year. Epidemic smallpox in the neighbouring Indian states of Bihar and Uttar Pradesh, however, resulted in an additional 239 outbreaks in 1972 and 1921 cases during the period 1973–1975. Most of these outbreaks could be traced directly or indirectly to importations and although they sometimes remained undetected for many weeks and were not always well contained, smallpox did not usually spread widely. On 6 April 1975, the last known case of smallpox occurred in Nepal as a consequence of an outbreak resulting from an importation from Bihar.

The Country: Geographical and Socio-cultural Considerations

Until 1951 Nepal, ruled by hereditary prime ministers, had been closed to the outside world, and no organized health services or educational facilities existed. When a constitutional monarchy was instituted in 1951, Nepal began the arduous task of building a transport, communication, health and educational infrastructure. Because of the mountainous nature of the country and the dearth of human and natural resources, progress was slow. Throughout the 1970s, Nepal remained one of the world's least developed countries.

Administratively, the country was divided into 14 zones, which were subdivided into 75 districts; the population of a district ranged from 7000 to 350 000, a far smaller figure than that for a district in India. The smallest administrative unit was the panchayat, of which there were some 4000.

Until the 1960s smallpox had occurred widely throughout Nepal. According to a health survey conducted in 1965–1966, 24% of people over 30 years of age in the capital city of Kathmandu bore the facial pockmarks of smallpox, as did 13% of those aged 10–29 years and 6% of children under 10 (WHO/SE/78.107, Shrestha). Variolation

was known to have been widely practised until recent years and many older persons bore the resulting scars. However, unlike the situation in Afghanistan (see Chapter 14), the practice had died out in Nepal by the time the Intensified Smallpox Eradication Programme began. No cases attributable to variolation were discovered during the course of the programme.

As in India, smallpox epidemics were reported to have occurred approximately every 5 years, the last having happened in 1958 (WHO/SE/78.107, Shrestha). However, up to 1963, there was no reporting system; indeed, until 1971 few reports were received from anywhere except the small districts comprising the Kathmandu valley, the site of the capital city. Some Nepalese, especially those living in the Terai, had been vaccinated in India, as had some living near Kathmandu or in the vicinity of the few health units that had vaccine. Otherwise, vaccination was little practised in Nepal.

Socio-economic and demographic factors played unusually important roles in the development of the programme and in the pattern of occurrence of the disease. Geographically, the country consisted of three horizontal belts (Fig. 15.27) extending across the country: the flat Terai of the Ganges river plain, with a population density ranging from 750 per square kilometre in the east to fewer than 100 per square kilometre in the less fertile west (Fig. 15.28); the Middle Hills area, with a terrain rising as high as 3000 metres and containing a few broad populous valleys including the Kathmandu valley, which had a population density of almost 1000 per square kilometre and about 5% of the country's inhabitants; and the Himalayan mountains, comprising 30% of the land surface but containing only 5% of the population. Very few people crossed the Nepal–China border, but travel across the Nepal–India border was unimpeded and frequent.

With only 680 kilometres of paved roads and 2 short railway lines (Fig. 15.27), there was little easy communication between the different areas of Nepal, although a network of footpaths connected the 29 000 villages and market centres in which 95% of the population resided. Kathmandu (population in 1971, 150 000) and Biratnagar (population, 45 000) were the only significant urban centres. On the other hand, contacts between the Terai and Kathmandu and India were numerous and were facilitated by the few motorable roads between the two countries.

The Nepalese of the Terai are Hindu and ethnically similar to their Indian neighbours. Many resisted vaccination for religious reasons; temples to Sītalā mata, the goddess of smallpox, were to be found throughout the

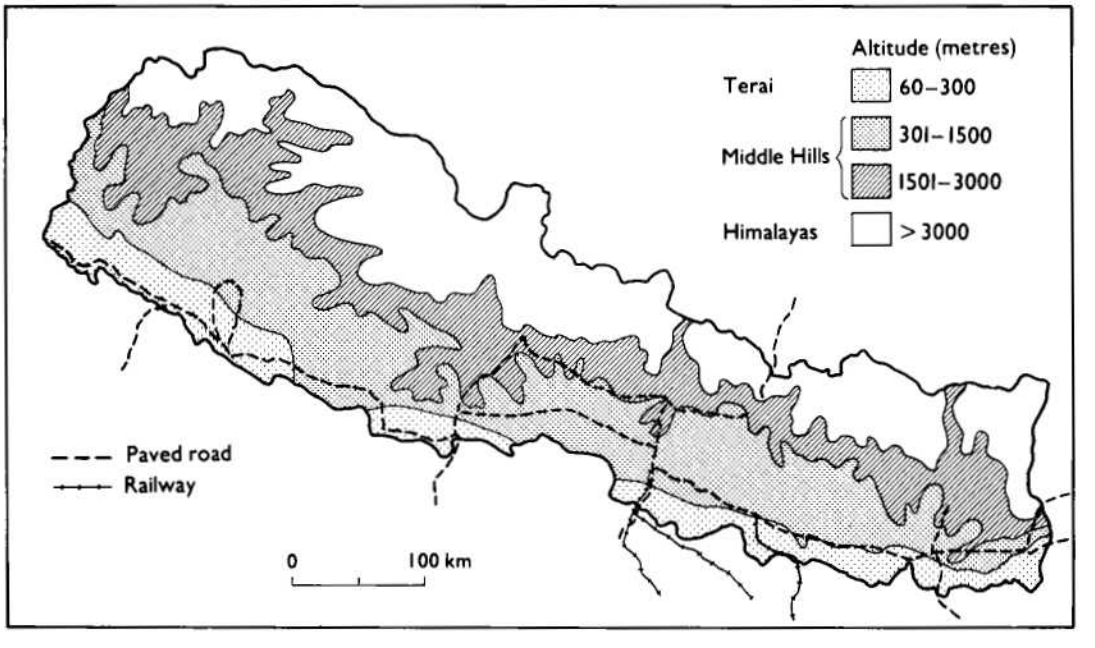


Fig. 15.27. Nepal: physical topography, showing paved roads and railways.

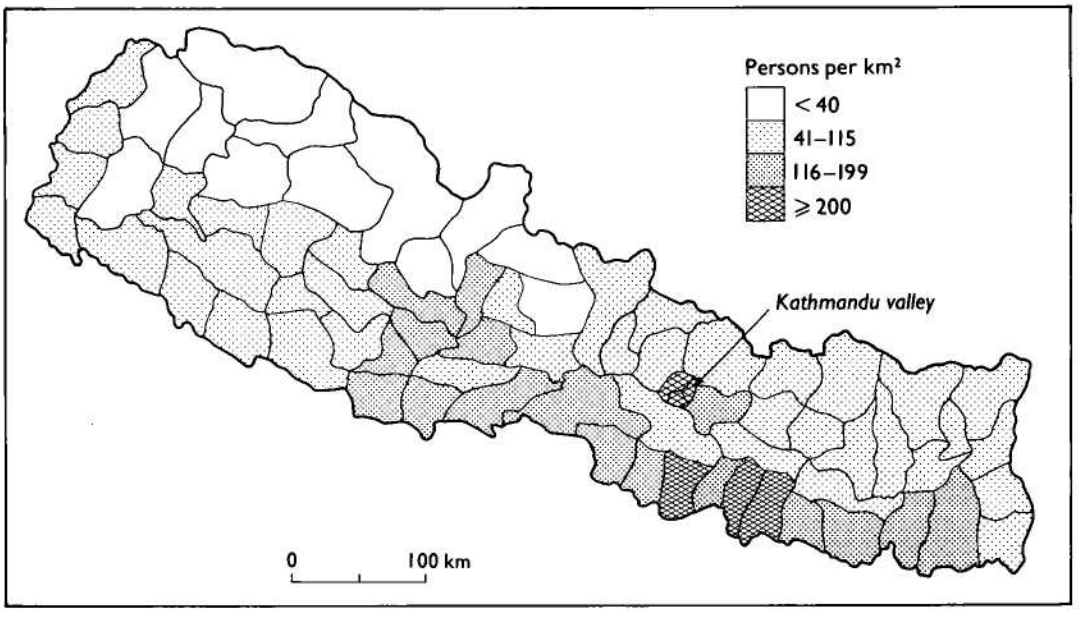


Fig. 15.28. Nepal: population density, by district.

region. The relatively rich agricultural and industrial area of the eastern Terai attracted numerous Bihari and Bengali seasonal migrants, who formed a sizeable proportion of the labour force. Travel to and from the less prosperous western Terai was limited primarily to family visits, and few travelled long distances. Those living in the Middle Hills were predominantly Hindu, but with the exception of some segments of the Newar ethnic group in the Kathmandu valley most people readily accepted vaccination. Travel to and from the Middle Hills was less frequent than within the Terai, although many moved to the Terai and to India for the winter months. Numerous inhabitants of the Eastern Hills worked on tea estates and as forest labourers in the Indian state of Assam and those in the Western Hills travelled to western Uttar Pradesh and cities of western India for work and trade. In the sparsely populated Himalayas, villages were isolated. To reach most districts from the endemic areas of India required a trek of more than 14 days—longer than the incubation period of smallpox. Because of these factors, smallpox proved to be primarily a problem of the Terai, only 4 outbreaks ever being detected in the extensive northern mountainous areas (SME/77.1, Shrestha et al.).

J.S. FRIEDMAN

Plate 15.18. At times, the roads in Nepal were almost impassable.

A Smallpox Control Pilot Project Begins, 1962

A smallpox control pilot project was initiated in 1962 in the 3 districts comprising the Kathmandu valley, which had a population of about 500 000 at that time (WHO/SE/69.10, Singh). With assistance provided by a WHO nurse already employed in another project in Nepal, a house-to-house mass vaccination campaign was begun, utiliz-

ing the multiple pressure method of vaccination and freeze-dried vaccine provided by WHO. As in India, all records were maintained in family registers in which the names of all residents of households were laboriously compiled, revised and updated. The programme was poorly funded, poorly supervised and poorly executed and with the additional impediment of resistance to vaccination progress was slow. A sample survey carried out late in 1964, 2½ years after the programme began, revealed that only 31% of the population had vaccination scars. In 1963, for the first time Nepal began to report cases of smallpox to WHO, but virtually all of them had occurred within the city of Kathmandu. In 1966, a WHO medical officer was assigned to assist the programme, but no effort was made to develop a national reporting system, and until 1968 the programme remained what it had been—an ineffective vaccination campaign confined to the Kathmandu valley. Repeat surveys in May 1967, conducted among various population groups in that area, showed that only 40–65% of the people examined had vaccination scars or the pockmarks of smallpox (WHO/SE/69.10, Singh).

The Programme Extends Beyond the Kathmandu Valley, 1968

In 1967 the government and WHO agreed on a phased plan to extend the programme zone by zone throughout the country. This commenced the following year with the hope that the last of the zones would be included in the programme by 1972. Additional resources were made available by the government, and WHO provided support in the form of personnel, vehicles and equipment and also covered the cost of petrol (Table 15.35). Staff were recruited, trained and assigned to district offices to serve as "senior vaccinators". During the first 3 months of a new vaccination campaign in a district, temporary vaccinators were hired to vaccinate widely throughout the district. Subsequent vaccination and surveillance were then the responsibility of the senior vaccinator. The family registers were abandoned and multiple puncture vaccination with bifurcated needles was introduced.

The number of districts covered by the programme grew from 3 in 1967 to 15 in 1968 and to 41 by the end of 1970. The number of vaccinations performed increased 10-fold, from 201 000 in 1965–1966 to 2 196 000 in 1968–1969 and to 2 823 000 in 1970–1971 (Table 15.36).

Community leaders and such health staff as were available were contacted and requested to report cases, but the numbers of cases notified remained few: 110 cases were reported in 1967, 249 in 1968, 163 in 1969 and 76 in 1970 (Table 15.37). Although reporting was very incomplete, it is probable that the true incidence in Nepal during these years was not high because the corresponding

Table 15.35. Nepal: financial inputs by the government of Nepal and WHO for smallpox eradication, 1962–1976 (US$)[a,b]

Year	Government of Nepal	WHO	Total
1962	2 447	–	2 447
1963	3 598	–	3 598
1964	4 702	–	4 702
1965	5 334	–	5 334
1966	6 000[c]	17 828	23 828[c]
1967	31 000[c]	68 875	99 875[c]
1968	53 615	100 590	154 205
1969	64 334	64 414	128 748
1970	82 400	6 589	198 989
1971	121 071	122 404	243 475
1972	147 339	158 629	305 968
1973	165 000	166 554	331 554
1974	163 500	94 993	258 493
1975	158 262	160 346	318 608
1976	169 343	129 815	299 158
Total	1 177 945	1 201 037	2 378 982

[a] Based on WHO financial records and data from the government of Nepal (SME/77.1, Shrestha et al.).
[b] Excluding the cost of 160 000 vials of vaccine.
[c] Estimated.

Table 15.36. Nepal: number of vaccinations performed, 1962–1976

Year	Total number of vaccinations	Number of primary vaccinations[a]	Percentage of primary vaccinations[a]
1962–1963	218 025	. .	. .
1963–1964	69 107	. .	. .
1964–1965	160 796	. .	. .
1965–1966	201 243	. .	. .
1966–1967	643 699	. .	. .
1967–1968	1 246 033	13 698	1.1
1968–1969	2 195 942	282 613	12.9
1969–1970	2 136 468	521 571	24.4
1970–1971	2 823 098	503 462	17.8
1971–1972	6 162 478	598 958	9.7
1972–1973	6 516 395	992 860	15.2
1973–1974	6 418 402	1 049 405	16.3
1974–1975	6 187 076	367 470	5.9
1975–1976	5 694 195	604 240	10.6

[a] . . = data not recorded.

Table 15.37. Nepal: reported number of cases of smallpox, by districts reporting cases, 1963–1975

Year	Number of cases	Number of districts in the programme	Number of districts reporting cases
1963	1 105	3	3
1964	135	3	3
1965	70	3	3
1966	164	3	3
1967	110	3	3
1968	249	15	8
1969	163	29	7
1970	76	41	1
1971	215	50	6
1972	399	58	9
1973	277	75	18
1974	1 549	75	28
1975	95	75	2

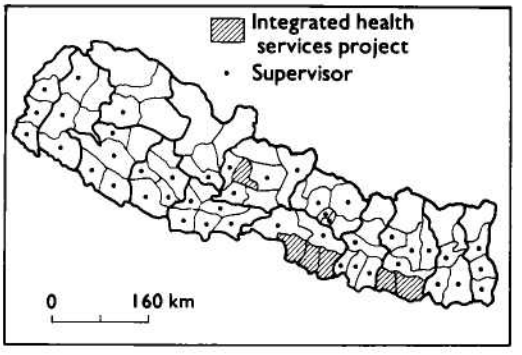


Fig. 15.29. Nepal: administrative divisions and location of district supervisors, 1971.

incidence in the neighbouring Indian states of Bihar and Uttar Pradesh was low.

The Programme Strategy Changes, 1971

Early in 1971, a new strategy, unique to Nepal, was adopted and effectively executed by an energetic Nepalese programme director, Dr P. N. Shrestha, and an experienced WHO smallpox adviser, Dr M. Sathianathan, from Sri Lanka, assisted by 2 United States technical officers—veterans of the western Africa programme—Mr Jay Friedman and Mr David Bassett. It was decided to extend the programme as soon as possible to cover the entire country. Forty-five Nepalese district supervisors were recruited and assigned to most districts in the Terai and Middle Hills, and assistant supervisors or senior vaccinators were sent to the other 30 districts, where each worked under the direction of one of the district supervisors. A senior supervisor was responsible for managing the programme in each of Nepal's 14 zones. In 6 districts, responsibility for smallpox eradication was assigned to a newly planned integrated health services project office (Fig. 15.29).

WHO and Nepalese staff decided that the vaccination campaign would be conducted during a single month in the winter of each year, and for this purpose temporary vaccinators (1 for each panchayat, comprising about 3000 persons) were recruited and trained during a 3-day training session. Simple tally sheets replaced the more elaborate record forms. During the remaining 11 months of the year, the assigned permanent smallpox eradication staff, numbering in all about 600 persons, travelled from village to village throughout the districts seeking information about smallpox from local leaders, schoolteachers and the personnel of health units. When cases were discovered, the staff were responsible for containment. Four central containment teams were formed to assist in this effort but were soon disbanded, since it proved impossible for them to reach the site of an outbreak before several days—or even weeks—had elapsed because of problems of communication and travel.

Despite the fact that mass vaccination was conducted during the course of a single month each year, the number of reported vaccinations increased to more than 6 million in 1971–1972—a number equivalent to 50% or more of the population—and continued at this level over the next 5 years. Surveys of vaccinial immunity, conducted in 1975 in many of the more accessible areas, revealed that in most of these areas more than 95% of the population bore vaccination scars.

Reporting improved as the programme extended its operations; by early 1973 weekly telegraphic reports were being received from each district regardless of whether any cases had occurred.

Because of the difficulties of travel, responsible district supervisors proved to be the vital element in the programme. They were brought to Kathmandu annually for refresher training and were visited as often as possible in the field by Nepalese and WHO staff, who, beginning in 1972, undertook to visit the site of each outbreak to assess the efficacy of the containment measures. To facilitate travel to the most remote districts, arrangements were made by WHO to permit the charter of a helicopter; it was used on perhaps a dozen occasions during the subsequent 3 years.

Plate 15.19. **A**: Purushollam N. Shrestha (b. 1939), the director of the smallpox eradication programme in Nepal from 1971. **B**: Jay S. Friedman (b. 1940), a WHO technical officer, being presented with a certificate of appreciation by the Prime Minister of Nepal, Tulsi Giri.

In 1972, the programme was extended to include all districts in the Terai and Middle Hills—the districts of greatest concern. Because of the isolation of the villages, most outbreaks were readily contained, and by the end of June 1972, transmission appeared to have been interrupted. During the last 6 months of the year, only 5 outbreaks, with 34 cases, were discovered (WHO/SE/74.71, Shrestha et al.); 4 resulted from importations from Uttar Pradesh and 1 from Bangladesh, whose north-western border with India was less than 50 kilometres—merely a day's journey—from Nepal.

However, as epidemic smallpox swept across Uttar Pradesh and Bihar in 1973, increasing numbers of cases began to be imported into Nepal (Fig. 15.30). In all, 43 outbreaks and 277 cases were reported that year, of which 35 outbreaks resulted from importations from India. Twenty-eight more cases occurred in these outbreaks that were not officially notified until 1974. Most of the imported cases had been infected in bordering districts of Uttar Pradesh and Bihar. The sources of the outbreaks included 12 districts in Uttar Pradesh and 9 in Bihar. One infected traveller came from the state of Maharashtra, although he was probably infected while travelling through Uttar Pradesh. All but 4 of the importations occurred in districts bordering on India.

Smallpox did not spread extensively, however. From the 35 importations, secondary spread to other villages occurred on only 7 occasions, one of these villages being the source of a further outbreak. The number of cases in each outbreak ranged from 1 to 38 with a mean of 8.3 cases, of which almost one-third (13 out of 43) were single-case outbreaks (Table 15.38).

In November and December 1973, the number of importations began to increase

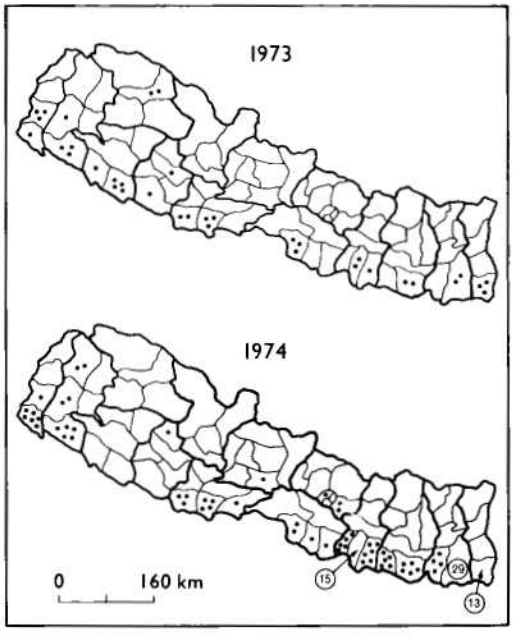


Fig. 15.30. Nepal: importations of smallpox, 1973 and 1974. Each dot denotes one outbreak.

Table 15.38. Nepal: number of outbreaks of smallpox, by number of cases in each outbreak, 1973–1975

Year	Total number of outbreaks	Number of cases in each outbreak					
		1	2–4	5–8	9–15	16–20	≥21
1973	43	13	8	7	5	4	6
1974	180	42	54	27	24	15	18
1975	16	7	4	2	0	1	2
Total	239[a]	63	65	36	29	21	25

[a] Data for 28 outbreaks not available.

and in January 1974, 14 importations were detected, of which 8 were from Bihar and 6 from Uttar Pradesh (Fig. 15.31). The number rapidly increased during May and then abruptly diminished, which was consistent with the seasonal decline in smallpox. In all, 180 outbreaks and 1549 cases occurred, of which 115 outbreaks were due to importations. As was the case in 1973, most of them (106 out of 115) occurred in districts bordering on India, the eastern districts of the Terai being the most heavily infected. In contrast to 1973, when the sources of infection were widely dispersed geographically, 68% of all importations during 1974 came from 5 heavily infected districts in Bihar. These districts, besides being among the most heavily infected in India, experienced severe food shortages in the spring of 1974 and, in consequence, many people migrated to Nepal.

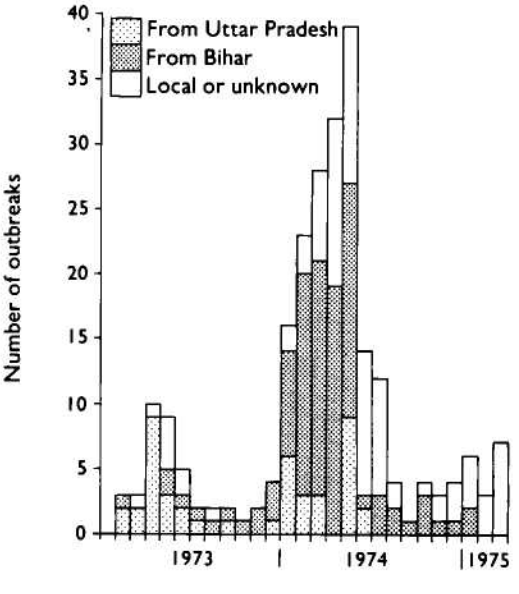


Fig. 15.31. Nepal: number of outbreaks of smallpox, by source, by month, 1973–1975.

In early 1974, WHO arranged for the prompt, reciprocal cross-notification by telegram between India and Nepal of possible sources of infection in each country. Programme staff agreed to investigate every report of this kind and to confirm whether an outbreak had been found. Nepalese staff fulfilled this responsibility well and detected a number of outbreaks not previously known. In India, especially in Bihar, the system operated far less well: with numerous outbreaks and a poorly organized health system, many reports were ignored (WHO/SE/74.71, Shrestha et al.).

The increase in the number of outbreaks in Nepal taxed the resources for surveillance and containment, and a greater number of outbreaks began to result from local spread. Nineteen out of 57 such outbreaks (167 cases) occurred between February and September following 2 importations into the Kathmandu valley. Most were in the Newar ethnic group, who had resisted vaccination for religious reasons, and among whom it was a common practice for the relatives and friends to visit those who were ill with smallpox. Detection was also difficult because families did not report cases and sometimes hid the patients from health officials. Smallpox could therefore spread widely and containment was difficult.

A second problem area was in the western Terai, in which another ethnic group who also resisted vaccination had the custom of granting any wish to a child with smallpox in the belief that the child was possessed by the goddess of smallpox, Sītalā mata. The child's wish was frequently to be taken to see relatives or friends in other villages. In this area, smallpox spread unusually rapidly among groups of villages (SME/77.1, Shrestha et al.).

A third area which proved difficult was a south-eastern district, Morang, which experienced 29 importations in 1974 and 1 in 1975. It was the centre of jute production in the eastern Terai and contained the industrial town of Biratnagar. Numerous migrant labourers from India were attracted to the area and, in the autumn of 1974, because of food shortages in Bihar, many beggars from India arrived there. Quite a few of the migrant labourers and most of the beggars belonged to a tribal group which worshipped Sītalā mata and resisted vaccination (SME/77.1, Shrestha et al.). The last chains of transmission began in December 1974 and

WHO / P. ROUCAS

Plate 15.20. Tibetan pilgrims being vaccinated in front of a Buddhist temple at Bodnath in the Kathmandu valley, Nepal.

January 1975, when 21 cases, primarily among beggars, occurred in a large market area, and from there smallpox spread to 6 nearby villages. More vigorous containment efforts were required; thus, in January, watchguards were posted at each infected house, as was done in India. In addition, systematic search and vaccination programmes were conducted over wide areas encircling the site of an outbreak. The system had been in use in many states of India for more than a year but in Nepal, in which the population was sparse, the containment of outbreaks had been less of a problem and, with fewer personnel, it had been impossible up to this time to adopt the Indian methods of containment. With the numbers of outbreaks diminishing both in India and in Nepal, a more elaborate scheme was possible. Resistance to vaccination was usually overcome with verbal persuasion although, on occasion, police accompanied the vaccinators to lend their authority. The number of outbreaks declined rapidly, and on 6 April 1975 the last cases occurred in Nepal.

Data regarding the age distribution of cases are available for 1286 of the 1921 cases which occurred in the period 1973–1975 (Table 15.39). Smallpox in Nepal occurred more frequently among older children and adults than in India. Less than one-third of all cases were in children under the age of 5 years and 29% were in persons over 15 years of age. The fact that more cases tended to occur in the older age groups in Nepal than in India probably reflected lower levels of vaccinial immunity throughout the population as well as a lower level of naturally acquired immunity due to the relative isolation of villages. Although villages in Afghanistan were comparable in their degree of isolation, vario-

Table 15.39. Nepal: age distribution of 1286 cases of smallpox, 1973–1975

Age group (years)	1973	1974	1975	Total	
				Number	%
0–1	16	119	4	139	11
2–4	51	214	12	277	21
5–14	87	374	38	499	39
⩾15	73	273	25	371	29
Total	227	980	79	1 286	100
Total number of cases reported	277	1 549	95	1 921	–

Plate 15.21. A Nepalese vaccinator at work. The plastic holder for bifurcated needles in the foreground was designed and first made in Pakistan; the vaccine came from the USSR.

lation had been extensively practised there and many persons were immune as a result. In Nepal, however, the procedure had been largely discarded in recent decades.

Only 40 out of 1915 patients (2.1%) for whom data are available had been vaccinated before exposure—a far lower proportion than that reported from India. Several factors could account for this. In India, in which rotary lancets had long been in use, many apparent vaccination scars resulted from sepsis rather than successful vaccination. In Nepal, few had been vaccinated with the rotary lancet. Moreover, in the vast majority of instances the vaccination had been performed after 1967 so that vaccinial immunity was likely to be at a higher level.

The case-fatality rate was 21.5% (411 deaths among 1915 patients), a figure consistent with observations elsewhere in the Asian subcontinent.

At the time that the last case occurred, a reward of 100 rupees (US$9.50) was being offered to anyone reporting a case, and later this sum was increased to 1000 rupees. After 6 April 1975, however, no reported case was

confirmed and no further cases were detected in subsequent laborious house-to-house searches.

Cost of the Programme

The total outlay on smallpox eradication by the government of Nepal and by WHO during 1962–1976 amounted to US$2 378 982, or just over US$0.15 per head of population. For the period 1972–1976, approximately 2% of the Ministry's health budget was spent on the programme. The expenditure, however, was low compared with the cost of other programmes such as that for malaria control, on which, in the year 1976–1977 alone, Nepal spent more than US$4.5 million (SME/77.1, Shrestha et al.).

SIKKIM AND BHUTAN

East of Nepal in the Himalayan mountains lay 2 small sparsely settled political entities—Bhutan and Sikkim (Fig. 15.32). Bhutan, an independent monarchy, had an estimated population (in 1967) of 987 000, which was concentrated in the central and southern parts of the country and had contact through trade and travel with the inhabitants of Assam, West Bengal and Bihar in India. Between Nepal and Bhutan was the even smaller and less populous Indian protectorate of Sikkim (population in 1967, 196 000), which in 1975 became a state of India. Both areas shared a northern border with China, but few travellers crossed it.

Sikkim and Bhutan were both at risk of smallpox imported from India, although in neither area had it seemed likely that smallpox transmission could be long sustained among the population of the scattered mountain villages. Thus, until smallpox transmission was interrupted in India and Bangladesh, little support was provided by WHO to either Sikkim or Bhutan and, in fact, information about the smallpox situation in both areas was scanty until late in the Intensified Programme. With the interruption of smallpox in India, attention was directed to these and other more remote areas of the subcontinent to ascertain something of the history of smallpox and smallpox control in recent years and to confirm that transmission was not continuing.

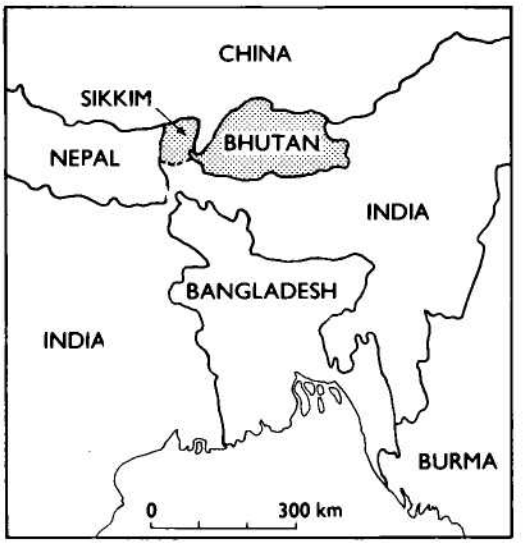


Fig. 15.32. Bhutan and Sikkim and adjacent countries.

Sikkim

Cases of smallpox had been officially reported in Sikkim since 1954. In 1966–1967, 78 cases in all were recorded at a time of high incidence in northern India. After this, no further cases were reported until 1973, when an outbreak of 34 cases occurred in Gangtok, the capital, the first case having been infected in Darjeeling, West Bengal. A second outbreak, of 11 cases, occurred that year in 2 villages along Sikkim's southern border, the source of infection again being West Bengal. No further cases were detected subsequently. Although reporting was undoubtedly very incomplete, the sporadic occurrence of smallpox was characteristic of an area in which importations were rare, and when they did occur, the disease did not spread easily.

Vaccination had been offered at the 4 district hospitals and 27 dispensaries, and the

Table 15.40. Sikkim and Bhutan: number of reported vaccinations, 1967–1975

Year	Sikkim	Bhutan
1967	114 575	35 944
1968	57 879	18 117
1969	71 812	9 029
1970	49 095	8 114
1971	36 832	43 052
1972	39 652	18 518
1973	45 801	57 375
1974	36 331	53 822
1975	28 846	25 599

number of vaccinations relative to population, at least from 1967, was quite substantial (Table 15.40). That vaccinial immunity was comparatively high was confirmed during a vaccination scar survey in November 1975, which revealed that 79% of the population had scars and only 42 of 1495 persons (2.8%) had the facial pockmarks characteristic of smallpox (Basu et al., 1979).

Bhutan

Information about Bhutan is less complete than for Sikkim. Until 1961 no health department had been established in the country. In 1964, the government created 19 posts for vaccinators, and increased the number to 25 in 1966, when a mass vaccination campaign was begun following an outbreak of 74 cases of smallpox in 1965–1966 in the capital city of Thimbu. The outbreak had begun among Indian and Nepalese workers employed in a road-building project and then spread to the local population. The number of vaccinations reported to have been performed between 1967 and 1975, however, was small in relation to the population of 987 000 (1967 estimate).

After the 1965–1966 outbreak, only 4 further outbreaks were reported. In 1967, 2 outbreaks originating in Assam caused 14 cases. The third outbreak, of 6 cases, occurred in April 1973 in a village near the south-western border with India, the initial case having been infected on a tea estate in West Bengal. The fourth outbreak, near the same border area, occurred in February 1974 and consisted of 3 cases, of which the first had been infected in Assam. Surveys conducted in 1976 to detect individuals with facial pockmarks, as well as interviews with village officials, indicate that other, unreported, outbreaks had occurred although none had produced more than a few cases. This was attributed in part to the fact that the villages were scattered and isolated, and in part to the sensible traditional practice of isolating the patient and his family at the onset of illness in a place some distance away from the village. In these circumstances, the spread of smallpox was difficult.

Sample surveys conducted in Bhutan in the autumn of 1976 confirmed that vaccinial immunity among children was generally low, especially in the central and northern parts of the country (Table 15.41).

Facial pockmarks indicative of past smallpox were not seen in anyone under 15 years of age in central and northern Bhutan but were observed in 11 children in southern Bhutan. In northern Bhutan, where adults also were examined, only 10 out of 244 persons (4%) over 15 years of age had the facial scars characteristic of smallpox, the youngest being in his late twenties.

In addition to the 11 children with facial pockmarks detected in the village surveys of southern Bhutan, 3 others were discovered during surveys of schools in this area. Nine of the 14 had experienced illness in 1967 or later, and in each instance efforts were made to identify the source of infection; all were traced to India. One had contracted smallpox while living in Allahabad, Uttar Pradesh, before moving to Bhutan. The other 8 became ill in outbreaks resulting from importations (Table 15.42).

Summary

The surveys confirmed the belief that the continuing transmission of smallpox in these sparsely populated, isolated countries had not occurred recently—even in Bhutan, in which vaccinial immunity was low. The tradition of isolating the patient and his family, observed in Bhutan, undoubtedly contributed significantly to stopping transmission. This custom, interestingly, was current throughout most mountainous areas of Asia, but was much less frequently practised in the lowlands.

Table 15.41. Bhutan: survey of vaccinial immunity and facial pockmarks in children, by age group, 1976

Area	Number of towns and villages surveyed	Number of children examined	Percentage vaccinated in age group (years)				Number with facial pockmarks
			<1	1–4	5–14	Total	
Northern Bhutan	37	152	11	30	56	44	0
Central Bhutan	12	7 952	26	55	70	59	0
Southern Bhutan	205	8 595	10	66	84	69	11

Table 15.42. Bhutan: number of reported cases of smallpox and sources of outbreaks, 1966–1974

Year of illness	Number of cases	Source of outbreak
1974 (February)	3	Assam
1973	6	West Bengal
1967	14	Assam
1966	64	West Bengal

CONCLUSIONS

From 1961, when India first decided to embark on a national eradication programme, to 1975, when the last case was detected, the programme gradually improved—in the quality of vaccine employed, in the vaccination technique used, in the reporting system, in the extent and intensity of surveillance and containment and, most important, in the quality of supervision. To undertake a national programme in a country so vast, with a population so large and a bureaucracy so complex, was inevitably difficult. To modify and redirect such a programme proved no less difficult. The dimensions of the effort, which involved at least the part-time participation of more than 150 000 field staff and contact with more than 550 million persons, are hard to grasp or communicate.

India's population, in 1967, constituted almost half of the total number of inhabitants of the endemic countries and, indeed, 15% of the world's entire population. The central direction of the enormous national campaign then in progress rested with only 1 medical officer and a small staff of clerks. In the states, of which 7 each had a population of more than 40 million, direction was generally entrusted to a single medical officer, for whom, in most instances, smallpox eradication was but a part-time responsibility. Working in the cities, towns and villages, however, were tens of thousands of vaccinators, basic health workers, family planning and malaria eradication programme staff and many other categories of health worker. Many were responsible, experienced individuals, conscientious about their jobs and willing to work, but they were seldom provided with much in the way of support or stimulus or the necessary supplies to carry out their assigned tasks. New directions or new policies were more often than not impersonally communicated by official memoranda which frequently demanded the impossible—for example: "All persons in the state will be vaccinated cent per cent [100%] during the next 12 months." Vehicles stood idle and refrigerators remained inoperative for want of petrol or a few spare parts because the monetary resources provided had proved inadequate and/or fiscal procedures were so cumbersome as to prevent the disbursement of the funds. Vaccine deliveries were erratic and numerous batches were unfit for use because of the lack of refrigerated storage.

In the opinion of many, the solution to the disappointing level of productivity throughout the health sector was to eliminate special programmes such as that for smallpox eradication and to integrate all programmes into a unified primary health care programme in which each health worker would assume a multiplicity of responsibilities as a "basic health worker". This was the panacea which had been repeatedly proposed by both Indian and WHO expert groups since the 1950s. It was the course of action recommended in 1966 as India's intensive national vaccination campaign drew to a close, with smallpox almost as widespread as it was before the campaign had begun. In a number of states such integrated programmes were started in the mid- and late 1960s but the productivity of the workers was, if anything, even lower than it had been before.

Given the difficult problems and the paucity of senior leaders, the achievements of the smallpox eradication programme between 1967 and 1973 were remarkable. By the summer of 1973, smallpox transmission had been virtually interrupted in the southern states and was declining in the western states. It seemed that a comparatively modest investment in time by senior epidemiologists to help to develop surveillance and containment activities in the other states should rapidly succeed in interrupting transmission throughout India. The deplorable condition of the health services in some of these states, especially Bihar, Assam and Uttar Pradesh, was not then comprehended, nor were the coming disastrous epidemics anticipated. However, the administrative changes which were made in the summer of 1973 had profound consequences in that they permitted the vast resources of health man power in India to be utilized effectively and gave scope to the imagination and problem-solving abilities both of senior staff and of field workers. With the active support of the Minister of Health and Family Planning and

an adequate complement of senior Indian and WHO staff to travel to the field to explore alternative solutions to problems, to instruct, to assess and to measure results, field staff took an increasing interest in the programme. Knowing what should be done, they themselves sought new solutions. The onerous fiscal constraints were ultimately resolved through the use of the flexible imprest accounts provided by WHO. With the most senior Indian staff, initially Dr Diesh and later Dr Sharma, not only travelling to state capitals but also visiting field staff in districts and villages, the example was set for otherwise desk-bound lower-level supervisory staff to do likewise. By doing so, they motivated and inspired staff at all levels.

The strategy adopted for the programme also played an important role, the country being divided into 3 different areas, with the objective of preventing smallpox from re-establishing itself in smallpox-free states, of eliminating the few remaining foci in states with a low incidence, and of conducting a major offensive in the 4 states with the highest endemicity. Each of the states thus had specific goals and programmes appropriate to those goals. Measurable indices of progress in achieving eradication were important. These were identified first in terms of the numbers of cases of smallpox occurring each week and then in terms of the numbers of outbreaks in which a case had occurred during the preceding 4 weeks. In the last year of the programme, other standards were formulated to measure the quality of surveillance, of containment and of outbreak investigation. With specified and achievable objectives, all personnel could assess progress in their own area, be it a primary health care centre, a district or a state. Monthly meetings and regular surveillance reports served as refresher training, permitting new approaches to be introduced and serving as a stimulus to all concerned.

The problems that emerged after the intensive campaign was launched in the summer of 1973 were far greater than anyone had expected, but the conviction of the senior leadership and the programme's momentum were sustained in the face of often hostile criticism by some senior Indian and WHO officials, natural calamities of flood and famine, civil disorder and strikes, and the inevitable bureaucratic inertia. The programme improved so rapidly that the transmission of smallpox was interrupted in India less than 20 months after the first search had begun. Because of the quality of the programme and the confidence achieved through assessment of its merits, it was possible only 3 months after the occurrence of the last case to celebrate India's freedom from smallpox on India's Independence Day in August 1975. In no other country up to that time had it been possible to feel so confident so soon. However, over the next 2 years, the programme staff conducted the most elaborate and extensive search programme of any in Asia to confirm for themselves and—just as important—to convince an incredulous world community that India was truly free of smallpox.

What many failed to appreciate was that the achievement was not the product of a special army dedicated to smallpox eradication, but one in which existing health staff of all types participated actively in managing and executing a programme with measurable objectives. When eradication was certified in 1977, only a handful of long-term smallpox vaccinators and a few senior staff remained to be reassigned to other programmes.

As had been expected, smallpox in Nepal, Bhutan and Sikkim reflected the experience in the neighbouring densely populated Indian states. In Bhutan and Sikkim, the only special activities undertaken, aside from routine vaccination programmes, were those concerned with certifying the absence of smallpox. In Nepal, far more populous and epidemiologically more closely related to India, a special programme was required.

The programme of vaccination and later of surveillance and containment in Nepal represented its first national health programme, and one which extended to all parts of this mountainous rugged country. Since travel throughout much of Nepal was of necessity by footpath, and health facilities were non-existent in many parts of the country, district smallpox supervisors played a vital role. With encouragement from national staff and repeated refresher training, most of these local workers responded well to their responsibilities. The first national disease reporting system was established, and vaccination—all but unknown in most of the country in 1967—reached more than 90% of the population within a period of little more than 5 years. It was an impressive achievement, especially in view of the fact that the ratio of programme staff to population was at

best 1 to 20 000. Nepal's successes were different from India's but no less remarkable.

The programme in India was slow to gain momentum and undoubtedly eradication might have been attained far sooner if an adequate complement of well-motivated senior supervisors had been provided at an earlier stage. In all probability, the greatest catastrophe of the Intensified Programme would have been averted—namely, the 1971 epidemic in the Calcutta Salt Lake Refugee Camp, which led to the reintroduction of smallpox into Bangladesh and to tens of thousands of deaths.