## CHAPTER 15

# INDIA AND THE HIMALAYAN AREA

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## INTRODUCTION

The Indian subcontinent has long been regarded as the probable place where smallpox originated—its traditional endemic home. It was a disease described in early Indian writings and enshrined both in Hindu religious belief and throughout the country in temples to the smallpox goddess. Variola major, with a case-fatality rate of 20% or higher, was the only variety of smallpox found in India and, as recently as the 1950s, it is estimated to have killed more than a million persons annually. Many held the view that because of population density, or for other ill-defined socio-cultural or epidemiological

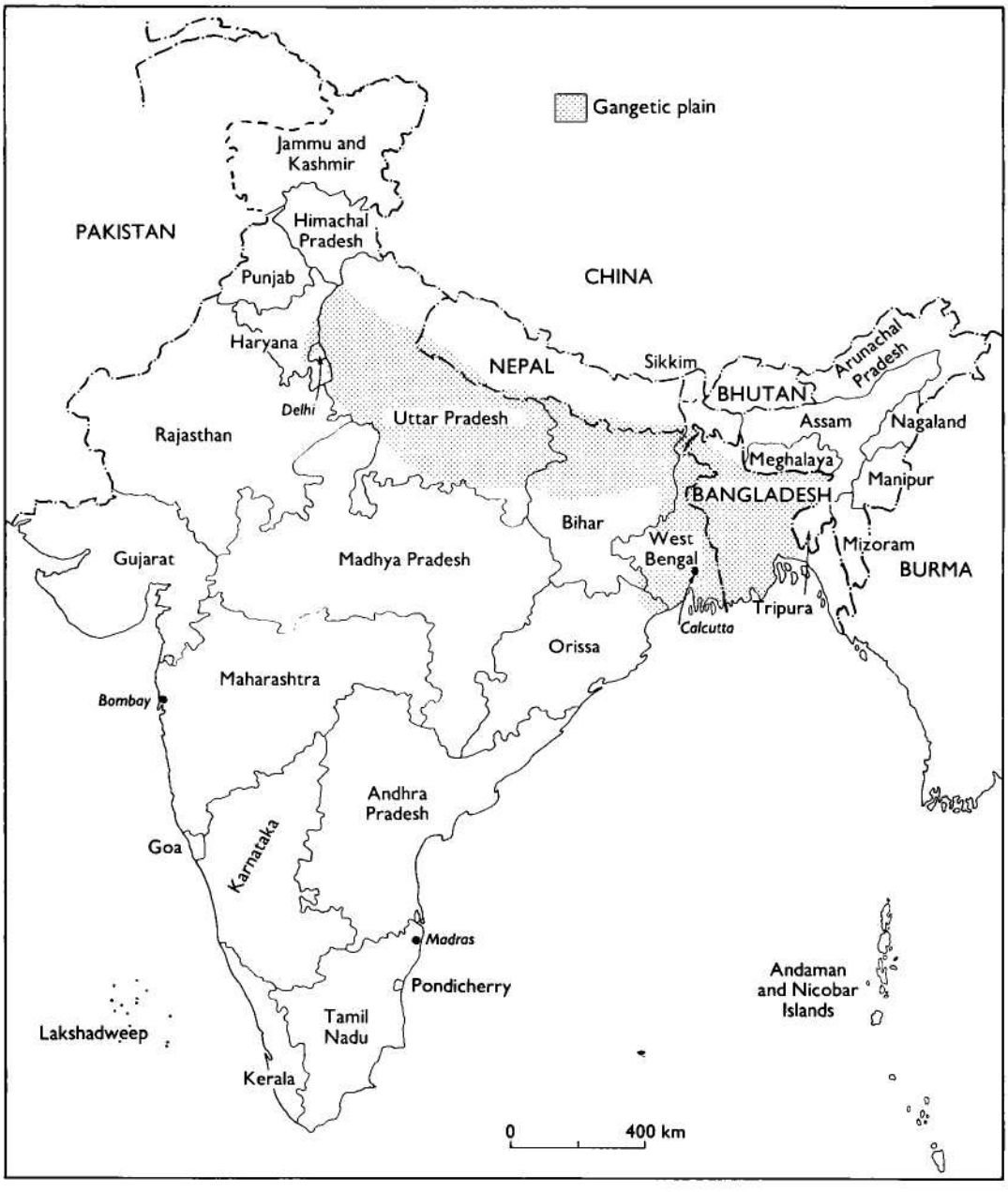


Fig. 15.1. Bhutan, the states and union territories of India, and Nepal. Many of the most densely populated areas in the region are in the Gangetic plain. In India, Karnataka was known as Mysore until 1973; Arunachal Pradesh was the North East Frontier Agency until 1971; and Sikkim became a state in 1975. Bangladesh was East Pakistan until 1971.

reasons, the eradication of smallpox in India would ultimately prove impossible. This belief had its roots in the behaviour of cholera, which for centuries had been confined to the riverine areas of the Indian subcontinent. In the 1830s, cholera spread across the world in the first of seven global pandemics, only to disappear over time, except from the Ganges river plain (Fig. 15.1). Although cholera was a bacterial disease with wholly different epidemiological characteristics, many believed that there were unique, yet unrecognized features of this area which would doom a smallpox eradication effort as certainly as an effort to eliminate cholera.

There were other reasons for pessimism. In area, India was the world's seventh largest country but second only to China in size of population. Of the 1100 million people living in areas which had endemic smallpox in 1967,

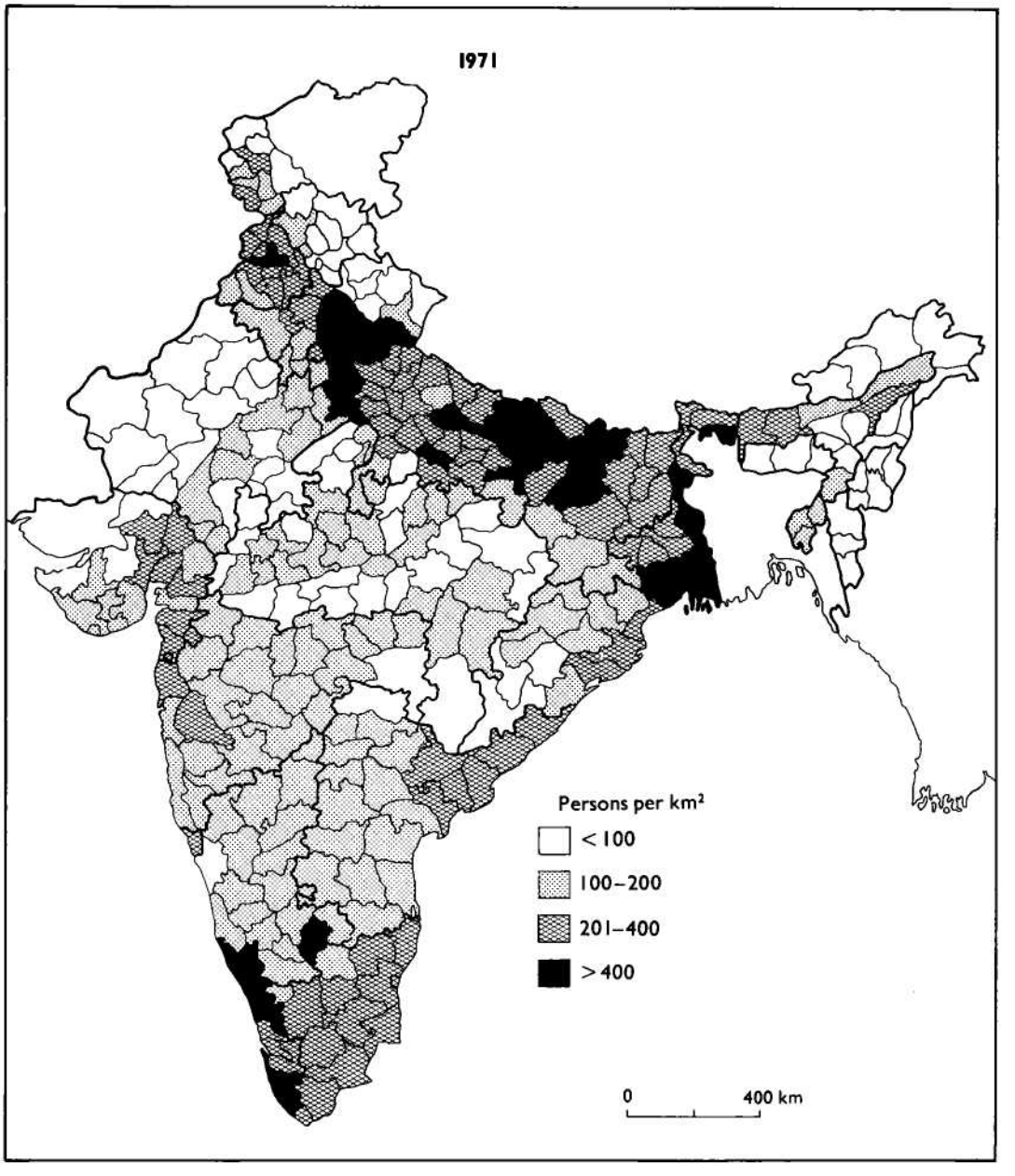


Fig. 15.2. India: population density, by district, 1971.

513 million (47%) lived in India. The most densely populated zone was the Ganges river plain in the north (Fig. 15.2), some 2400 kilometres long and 240–320 kilometres wide. Sharing borders with India and epidemiologically related to it were the 2 small Himalayan mountain kingdoms of Nepal (population 10.8 million) and Bhutan (population, 987 000), and the Indian protectorate of Sikkim (population, 196 000). (Sikkim became an Indian state in 1975.)

A smallpox eradication campaign had begun in India in 1962 (Fig. 15.3) but, despite an intensive and costly effort, smallpox was still widely prevalent in 1967 and substantially underreported throughout the country. A pilot smallpox control programme had been launched in Nepal in 1962, but cases continued to be reported from the only 3 districts which reported at all. Little was known in 1967 about the situation in Bhutan and Sikkim.

In 1967, the meagre resources available to WHO precluded the provision of meaningful support to all endemic countries in Asia. A programme was already established in India, although functioning poorly, and India at that time requested international assistance only to permit the acquisition of equipment for vaccine production. Thus, WHO's assistance in Asia was directed to the less populous endemic countries—Afghanistan, Indonesia, Nepal and Pakistan (which then included East Pakistan, later to become Bangladesh). It was hoped that successful programmes in these countries would eventually permit the release of significant resources in support of the Indian national programme if required. A joint India–WHO team assessed the Indian programme in 1967 and, subsequently, WHO staff from Headquarters and the Regional Office for South-East Asia in New Delhi held frequent meetings with Indian government staff. Until 1970, however, progress was slow. That year, a WHO–India agreement was signed which provided for WHO support for field activities. During the following 3 years considerable progress was made in the southern and western states but little in the northern, densely populated Ganges river plain. Meanwhile, country after country in Africa, South America, and Asia succeeded in interrupting smallpox transmission. By June 1973, only 5 endemic countries remained, of which 4 were adjoining countries in Asia (Bangladesh, India, Nepal and Pakistan) and the fifth was in Africa (Ethiopia).

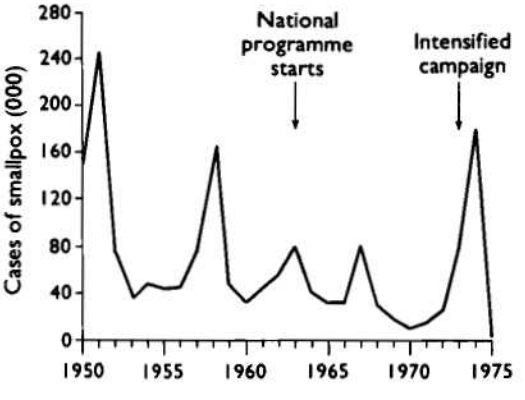


Fig. 15.3. India: number of reported cases of smallpox, by year, 1950–1975.

In June 1973, Indian and WHO staff decided on an ambitious campaign to involve more than 100 000 local health staff throughout India in a village-by-village search for cases. Such searches would be completed in 7–10 days and would be undertaken monthly in heavily infected areas and less often in areas in which few or no cases were being reported. Outbreaks, when found, would be contained by local health staff assisted by state and district surveillance teams. With this strategy, it was hoped that transmission might be sharply curtailed by January 1974 and perhaps interrupted as early as June 1974. The problems proved far more formidable than had been foreseen. Although the original optimistic target was not met, transmission was interrupted in May 1975, less than 2 years after the special programme had begun—a considerable achievement in so vast a country.

In sheer magnitude and scope, in innovation and adaptation to adversity, in dedication and enthusiasm, in the degree of international cooperation and understanding, the Indian programme from September 1973 onwards was one of the finest endeavours of the global campaign. It is impossible to do full justice to this vast programme in a single chapter. Fortunately, a number of publications describe the overall programme, focusing primarily on its concluding phase. Two books, *The Eradication of Smallpox from India* (Basu et al., 1979) and *The Management of Smallpox Eradication in India* (Brilliant, 1985), are particularly valuable. Special issues of the *Indian journal of public health* (January–March 1978) and *The journal of communicable diseases* (August 1975) also provide important information.

This chapter includes an account of the closely related and ultimately well-executed Nepalese programme, of which there is no published description. It concludes with such information as is available regarding activities in Bhutan and Sikkim, which experienced only infrequent importations after 1966.

## INDIA

### Background

India's immense size and vast population, of whom more than 80% lived in rural areas, was but part of the challenge. In India, as well as in East and West Pakistan, there was an extraordinary movement of population from place to place for purposes of business and attendance at marriages and funerals. Numerous religious pilgrimages and gatherings attracted huge crowds, sometimes amounting to millions of people. Uncountable hundreds of thousands travelled throughout the country on 10 800 daily trains. The state transport system, including buses and other motor vehicles, alone carried some 10 million passengers (about 2% of the population) each day. Reflecting the extent of internal migration, the 1961 census showed that a third of the population was enumerated outside their places of birth that year; during succeeding years, mobility substantially increased. This was important in smallpox transmission. Often, persons who were exposed to or became ill with smallpox would journey long distances to return to their home villages, disseminating smallpox when they arrived and sometimes in the course of the journey.

Also unique to the Indian setting was a belief among Hindus that attributed smallpox to the wrath of a goddess, called Sītalā (Shitala) mata although known by a number of different names among India's 15 major language groups and 250 regional dialects. It was not surprising that a deity was associated with smallpox, considering the antiquity of the disease and the large numbers of people it afflicted, of whom 1 in 5 died. Its severity was illustrated by the fact that as late as the mid-1800s, 13% of all recorded deaths in Calcutta were due to smallpox, and 75% of blindness in India at that time was attributed to the disease (Rogers, 1944). Some persons resisted vaccination, fearing that it would anger the goddess. Religious ceremonies in her honour were common at specially dedicated temples as well as in people's homes.

Finally, there were the complexities of the administrative structure. India, a parliamentary democracy, was divided into 21 states and 9 union territories. (In 1975, Sikkim became the 22nd state.) These were further subdivided into 393 districts and 5247 community development blocks (Table 15.1). Of the 575 721 villages enumerated in the census of 1971, approximately 319 000 had a population of less than 500; only 6333 had a population of more than 5000. There were only 4 cities with more than 2 million inhabitants: Calcutta (7 million), Bombay (6 million), Delhi (3.6 million), and Madras (3 million).

At the national level, responsibility for health programmes was shared by the Minister of Health, a political figure; the Secretary of Health, a non-technical administrative executive officer; and a technical Director-General of Health Services, who implemented health programmes. Substantive decisions required the collaborative understanding of all three. In each state the administrative structure replicated the national one. Although there was some variation in the type of organization from state to state, there were district health units in most, directed by a chief medical officer of health (or civil surgeon). In large states, several districts were grouped in divisions and, for each, there was a divisional medical officer. Districts were divided into basic health units termed primary health centres (corresponding usually to community development blocks), which attended to the health needs of 80 000–150 000 people living in 150–350 villages.

### Smallpox in India before 1962

Vaccination had first been performed in India in 1802 and an organized vaccination programme was begun in Bombay in 1827 (Rogers, 1944). By 1868, some type of vaccination programme had been established in all provinces, although little was done in most of the 560 independent princely states, in which about a third of the population resided. With increasing numbers of vaccinations, the numbers of registered deaths from smallpox declined between 1878 and 1937, despite a progressively improving system for the regis-

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**Plate 15.1.** The goddess of smallpox has long been worshipped throughout the Indian subcontinent. She is usually portrayed as a woman riding on an ass, carrying a broom in one hand and a waterpot in her other arm. In northern India, she was known as Śītalā mata, śītalā meaning the cool one, and mata meaning mother. Though worshipped primarily by Hindus and Jains, in Nepal she was incorporated in the Buddhist pantheon as Ajima, the mother of Gautama Buddha. Offerings were made at temples dedicated to her and to images in the home; annual festivals were held on her feast day. Beliefs and practices differed from place to place and the goddess was variously considered to have powers to prevent or cure the disease as well as to inflict it.

Table 15.1. India: political divisions, area and population distribution, 1971[a]

| Region and state or union territory[b] | Area ($km^2$) | Population (1971) | Population density/$km^2$ | Number of | | | |
|---|---|---|---|---|---|---|---|
| | | | | Districts | Blocks | Towns | Villages |
| **South:** | | | | | | | |
| Andaman and Nicobar Islands[c] | 8 293 | 115 133 | 14 | 2 | 5 | 1 | 390 |
| Andhra Pradesh | 276 814 | 43 502 708 | 157 | 21 | 324 | 207 | 27 221 |
| Dadra and Nagar Haveli[c] | 491 | 74 170 | 151 | 1 | 2 | — | 72 |
| Goa, Daman and Diu[c] | 3 813 | 857 771 | 225 | 3 | 12 | 13 | 409 |
| Kerala | 38 864 | 21 347 375 | 549 | 11 | 144 | 88 | 1 268 |
| Lakshadweep[c] | 32 | 31 810 | 994 | 1 | 4 | — | 10 |
| Maharashtra | 307 762 | 50 412 235 | 164 | 26 | 426 | 257 | 35 778 |
| Mysore[d] | 191 773 | 29 299 014 | 153 | 19 | 268 | 230 | 26 826 |
| Orissa | 155 782 | 21 944 615 | 141 | 13 | 314 | 78 | 46 992 |
| Pondicherry[c] | 480 | 471 707 | 983 | 4 | 4 | 5 | 333 |
| Tamil Nadu | 130 069 | 41 199 168 | 317 | 15 | 374 | 241 | 15 735 |
| **East:** | | | | | | | |
| Assam | 78 523 | 14 625 152 | 186 | 10 | 130 | 69 | 22 224 |
| Manipur | 22 356 | 1 072 753 | 48 | 6 | 26 | 8 | 1 949 |
| Meghalaya | 22 489 | 1 011 699 | 45 | 3 | 24 | 3 | 4 583 |
| Mizoram[c] | 21 087 | 332 390 | 16 | 3 | 20 | 2 | [f] |
| Nagaland | 16 527 | 516 449 | 31 | 7 | 21 | 3 | 960 |
| North East Frontier Agency[c,e] | 83 578 | 467 511 | 6 | 5 | 43 | 4 | 2 973 |
| Tripura | 10 477 | 1 556 342 | 149 | 3 | 17 | 6 | 4 727 |
| **West:** | | | | | | | |
| Chandigarh[c] | 114 | 257 251 | 2 257 | 1 | 1 | 1 | 26 |
| Delhi[c] | 1 485 | 4 065 698 | 2 738 | 2 | 5 | 1 | 243 |
| Gujarat | 195 984 | 26 697 475 | 136 | 19 | 250 | 200 | 18 275 |
| Haryana | 44 222 | 10 036 808 | 227 | 11 | 87 | 65 | 6 731 |
| Himachal Pradesh | 55 673 | 3 460 434 | 62 | 12 | 69 | 35 | 16 916 |
| Jammu and Kashmir | 222 236 | 4 616 632 | 21 | 10 | 74 | 43 | 6 503 |
| Punjab | 50 362 | 13 551 060 | 269 | 12 | 117 | 106 | 12 188 |
| Rajasthan | 342 214 | 25 765 806 | 75 | 26 | 232 | 151 | 33 305 |
| **Central:** | | | | | | | |
| Bihar | 173 876 | 56 353 369 | 324 | 31 | 587 | 161 | 67 566 |
| Madhya Pradesh | 442 841 | 41 654 119 | 94 | 45 | 457 | 233 | 70 883 |
| Uttar Pradesh | 294 413 | 88 341 144 | 300 | 55 | 875 | 293 | 112 561 |
| West Bengal | 87 853 | 44 312 011 | 504 | 16 | 335 | 137 | 38 074 |
| Total | 3 280 483 | 547 949 809 | 167 | 393 | 5 247 | 2 641 | 575 721 |

[a] From Basu et al. (1979), including the population estimates. United Nations (1985) data show a total population of 564 207 000 for India as a whole in 1971.

[b] The regional divisions (South, East, West and Central) shown in this and other tables were designated by the staff of the Intensified Smallpox Eradication Programme on the basis of the epidemiological characteristics of smallpox and the status of the programme in 1972. Reference is made to them in describing the progress of the programme. Sikkim, which became a state of India in 1975, is not listed.

[c] Union territories.

[d] Became the state of Karnataka late in 1973.

[e] Became the union territory of Arunachal Pradesh in 1972.

[f] Included in Assam.

Table 15.2. India: population, number of recorded deaths from smallpox, average annual number of vaccinations, and percentage of population vaccinated annually, 1878–1937[a] (British India) and 1962–1971

| Years | Population | Total number of deaths | Average annual number of vaccinations | Percentage of population vaccinated annually |
|---|---|---|---|---|
| 1878–1887 | 190 000 000 | 1 460 890 | 4 750 000 | 2.5 |
| 1888–1897 | 206 000 000 | 961 424 | 6 750 000 | 3.3 |
| 1898–1907 | 222 000 000 | 832 165 | 8 750 000 | 3.9 |
| 1908–1917 | 234 000 000 | 851 999 | 9 500 000 | 4.0 |
| 1918–1927 | 240 000 000 | 832 477 | 14 500 000 | 6.0 |
| 1928–1937 | 263 000 000 | 763 279 | 19 100 000 | 7.3 |
| 1962–1971 | 513 000 000[b] | 113 372 | 91 940 000 | 18.0 |

[a] From Rogers (1944).

[b] United Nations (1985) estimate for 1967.

tration of deaths and a growing population (Table 15.2). Data comparable to those provided by Rogers could not be obtained for the period 1937–1961, but data for 1962–1971 are available—1962 being the year in which India commenced a special national smallpox eradication programme (see below). It is not known how complete the registration of deaths may have been at different times. However, studies conducted during the early 1970s showed that even then, the number of reported cases of, and presumably deaths from, smallpox represented less than 5% of the cases and deaths that had actually occurred.

Vaccination programmes were gradually extended throughout most of the country and, following India's independence in 1947,

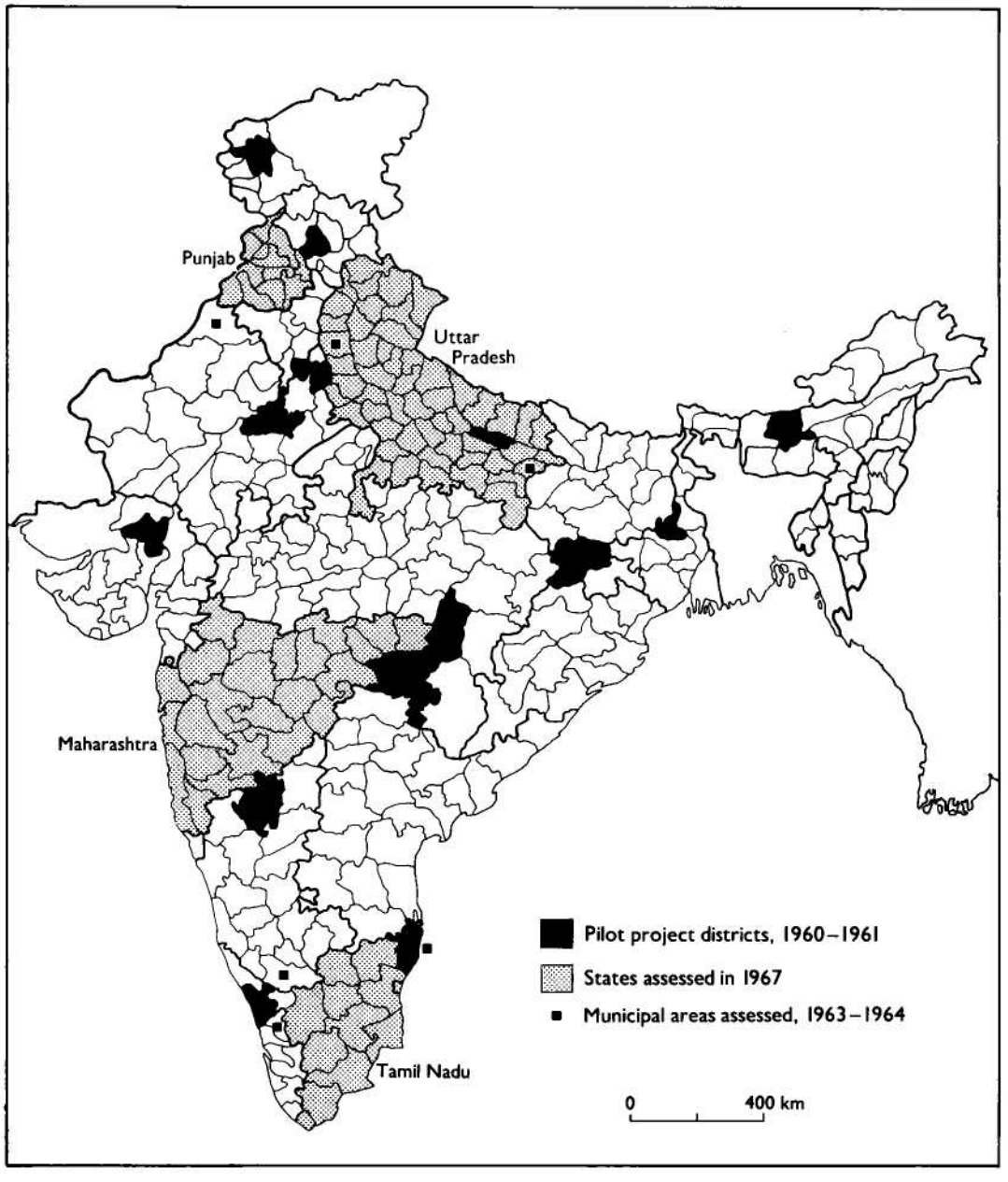


Fig. 15.4. India: pilot project districts for the National Smallpox Eradication Programme (NSEP), 1960–1961; state programmes assessed in 1967; and municipal areas assessed, 1963–1964.

to the remaining princely states. Thermolabile liquid vaccine was the only vaccine available and many of the vaccinations performed must have been unsuccessful. This vaccine was produced in 14 laboratories in 11 different states. As in Pakistan, vaccinators who were recruited and hired by the local administrative organization and termed "local body vaccinators" performed the vaccinations. The programme of vaccination provided only partial control of smallpox, but because vaccination was widely available and variolation was forbidden by law, the latter practice ceased and, by the late 1950s, was no longer a problem in India.

## India's National Smallpox Eradication Programme, 1962

In June 1959, one month after the decision of the Twelfth World Health Assembly to undertake a global eradication programme, an Expert Committee of the Indian Council of Medical Research recommended that a National Smallpox Eradication Programme should be established. The vaccination campaign that resulted was of heroic dimensions and, although failing in its goal to eradicate smallpox, it served to extend vaccination to all but the most isolated villages and created an army of workers and a momentum which provided a foundation for the subsequently successful eradication effort.

Pilot projects were first developed in one district per state to work out methodology and to develop estimates of costs and personnel requirements (Fig. 15.4). The projects began in 1960 and concluded in March 1961 (India, Ministry of Health and Family Planning, 1966).

The essence of the strategy called for a specially recruited team to move systematically from house to house and from village to village throughout a district in an effort to vaccinate or revaccinate not less than 80% of the population. With this proportion vaccinated, it was expected that a sufficient number of persons would be immune so that smallpox transmission would terminate spontaneously. The vaccination team was preceded by enumerators, who listed in a large multi-page register the name of each person along with his or her address, age, sex and previous history of vaccination or of smallpox. One register was compiled for each village or defined area in a city and was intended to be used during the subsequent 20 years. After enumeration had been completed, the register was given to the vaccination team, which then endeavoured to vaccinate those who were listed. The register was next given to an inspector, who was to check each vaccinee to ensure that vaccination had been successful. Subsequently, local health unit vaccinators (1 for every 50 000–70 000 persons) were assigned responsibility to vaccinate those missed in the mass campaign ("mopping-up vaccination"), to maintain the registers, to revaccinate everyone every 5 years and to vaccinate contacts when cases were discovered. Performance in the pilot projects was poor. In a target population of 23 million, only 12 million (52%) were vaccinated. No evaluation of the programme was conducted nor was smallpox incidence monitored. Nevertheless, as happens only too frequently, the pilot projects were followed almost immediately by the introduction of a national programme.

The USSR offered freeze-dried vaccine, which was largely but not entirely intended to replace the thermolabile liquid vaccine; the United States Agency for International Development made a grant of rupees equivalent to US$2 million; and UNICEF pledged equipment for vaccine production. Eventually, the USSR provided 650 million doses of vaccine and the USA, between 1961 and 1967, contributed the rupee equivalent of US$23 million, which had been generated by the sale of foodstuffs provided to India (termed Public Law 480 funds).

Since health programmes in India are constitutionally a state responsibility, the principal administrative direction of the smallpox eradication programme was delegated to the states. Only 2 professional staff provided coordination at the national level. However, because smallpox was considered a national priority, the programme was "centrally sponsored"; the states were reimbursed by the central government for all non-recurring expenditures and for 75% of recurring costs.

The government created 152 units, each of which was expected to vaccinate about 3 million persons in an "attack phase" lasting 2–3 years. Each unit consisted of a supervising officer (usually a physician), a paramedical assistant, 60 vaccinators, 12 inspectors, 12 enumerators and 2 health educators. Each unit was assigned 3 vehicles. In all, more than 13 000 persons were employed, most of whom

**Recommendations for Primary Vaccination in Early Childhood, 1963**

The programme's recommendations for primary vaccination were taken from a publication of the British Ministry of Health and distributed in a circular to all administrative staff in 1963. It stated that primary vaccination "should be carried out some time before the age of two years, preferably during the second year" and listed as specific contraindications: "failure to thrive, exposure to infectious disease, septic skin conditions, infantile eczema and other allergic conditions, hypogammaglobulinaemia and corticosteroid treatment" (India, Ministry of Health and Family Planning, 1966). Although perhaps appropriate for the United Kingdom, where smallpox cases were only occasionally imported, the recommendations were inappropriate for India, where many children were exposed to smallpox from birth, where the risks associated with vaccinating most of those with the listed contraindications were much less than the risk of death due to smallpox, and where most vaccinations were performed by scarcely literate vaccinators who could not be expected to recognize many of the conditions noted. Indeed, if all the contraindications had been carefully observed in India, few children would have been vaccinated. Sensibly, the recommendations were largely ignored by most vaccinators, although some did not vaccinate children who were ill with fever or had skin infections. Throughout India, 3 months of age was generally respected as the lower age limit for vaccination. By 1970, a more realistic and appropriate policy had evolved. It called for vaccination from the time of birth and recognized no contraindications except one: vaccinators were instructed not to vaccinate seriously ill persons who might be expected to die over the succeeding day or two and whose death might thus erroneously be attributed to vaccination.

were newly hired and trained. The programmes were launched in 1962 and 1963.

Between 1962 and 1966, 440 million vaccinations were reported to have been performed. It was an impressive number but it did not signify that this many persons had been rendered immune. The first indication of difficulties was observed in New Delhi in the winter of 1963 (Gelfand, 1966). Between December 1962 and May 1963, 346 cases of smallpox occurred in an area in which the number of vaccinations performed was equivalent to more than 80% of the population. Sample surveys conducted in 18 representative areas revealed that, in fact, vaccinations had been given to only 63% of the population and that, of these, 86% had been successful. It was therefore concluded that only 54% of the population had been successfully vaccinated. This discrepancy between the number of vaccinations reported and the number of people actually rendered immune was attributed to a falsification of records and the repeated vaccination of readily accessible groups, particularly schoolchildren. The government was disturbed by these findings and asked India's National Institute of Communicable Diseases to undertake similar surveys in other states. Five were subsequently conducted in districts which reported that the number of vaccinations performed was equivalent to 80% or more of the population. In operational terms, this meant that the mass campaign "attack phase" had been completed or was about to be completed and the "maintenance phase" was due to begin; during the latter phase the established health services would assume the responsibility for sustaining levels of vaccinial immunity and for controlling outbreaks.

The findings of the National Institute's teams were not encouraging (Gelfand, 1966). The family registers—printed sheets sewn together in a large book—were supposed to include the name of each individual in a defined area and to provide a permanent record of vaccination status. Field assessment showed that many registers had already been lost or were so worn as to be unusable; many names had been omitted; and the clerical task of keeping the registers up to date was overwhelming. It was found, for example, that some individuals who had died as long as a year before were recorded as having just been successfully revaccinated. However in-

Table 15.3. India: number of reported cases of smallpox, by state or union territory, 1962–1975

| State or union territory | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **South**[a] | | | | | | | | | | | | | | |
| Andhra Pradesh | 3 065 | 3 519 | 3 256 | 2 339 | 981 | 8 618 | 7 951 | 1 893 | 358 | 214 | 405 | 1 295 | 281 | 0 |
| Dadra and Nagar Haveli | 0 | 0 | 0 | 0 | 0 | 18 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Goa, Daman and Diu | 16 | 4 | 0 | 180 | 127 | 45 | 18 | 12 | 1 | 0 | 0 | 0 | 0 | 0 |
| Karnataka | 1 310 | 2 844 | 787 | 1 879 | 1 708 | 1 770 | 981 | 178 | 126 | 223 | 1 299 | 6 | 11 | 0 |
| Kerala | 925 | 1 021 | 62 | 157 | 517 | 152 | 2 | 9 | 31 | 0 | 0 | 0 | 4 | 0 |
| Lakshadweep | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maharashtra | 6 820 | 15 323 | 6 567 | 7 484 | 8 092 | 27 961 | 3 173 | 1 411 | 174 | 160 | 215 | 158 | 448 | 0 |
| Orissa | 1 175 | 4 185 | 906 | 1 611 | 404 | 3 806 | 3 200 | 1 247 | 105 | 16 | 5 | 1 276 | 2 170 | 6 |
| Pondicherry | 40 | 60 | 53 | 102 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tamil Nadu | 8 588 | 8 901 | 5 545 | 3 377 | 789 | 263 | 150 | 6 | 0 | 7 | 1 | 3 | 15 | 0 |
| **East** | | | | | | | | | | | | | | |
| Arunachal Pradesh | 0 | 0 | 0 | 0 | 82 | 27 | 132 | 118 | 0 | 0 | 4 | 2 | 2 | 0 |
| Assam | 358 | 250 | 177 | 183 | 601 | 458 | 507 | 640 | 77 | 35 | 8 | 458 | 6 243 | 88 |
| Manipur | 0 | 18 | 0 | 6 | 82 | 33 | 4 | 0 | 0 | 0 | 0 | 13 | 11 | 0 |
| Meghalaya | *b* | *b* | *b* | *b* | *b* | *b* | *b* | *b* | 0 | 0 | 0 | 30 | 498 | 61 |
| Mizoram | *b* | *b* | *b* | *b* | *b* | *b* | *b* | *b* | 0 | 0 | 0 | 1 | 0 | 0 |
| Nagaland | .. | .. | 0 | 0 | 31 | 28 | 0 | 0 | 0 | 0 | 0 | 45 | 45 | 0 |
| Tripura | 13 | 2 | 0 | 104 | 0 | 109 | 341 | 0 | 0 | 0 | 6 | 9 | 0 | 9 |
| **West** | | | | | | | | | | | | | | |
| Chandigarh | *c* | *c* | *c* | *c* | .. | 12 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 |
| Delhi | 175 | 484 | 92 | 296 | 475 | 472 | 70 | 28 | 96 | 318 | 149 | 168 | 142 | 0 |
| Gujarat | 1 327 | 609 | 79 | 310 | 1 170 | 3 403 | 7 654 | 6 284 | 2 492 | 238 | 39 | 9 | 5 | 16 |
| Haryana | *c* | *c* | *c* | *c* | 149 | 4 809 | 633 | 683 | 2 161 | 2 635 | 1 532 | 188 | 71 | 0 |
| Himachal Pradesh | 11 | 101 | 2 | 21 | 24 | 44 | 2 | 0 | 1 | 11 | 0 | 2 | 7 | 0 |
| Jammu and Kashmir | 35 | 33 | 9 | 7 | 0 | 40 | 1 | 7 | 0 | 11 | 272 | 941 | 760 | 0 |
| Punjab | 4 848 | 1 727 | 319 | 380 | 859 | 1 393 | 76 | 228 | 234 | 101 | 139 | 65 | 53 | 0 |
| Rajasthan | 3 900 | 3 370 | 1 938 | 1 652 | 1 555 | 4 506 | 1 923 | 1 439 | 4 097 | 4 827 | 1 970 | 877 | 61 | 0 |
| **Central** | | | | | | | | | | | | | | |
| Bihar | 378 | 4 760 | 8 484 | 5 398 | 6 590 | 11 873 | 3 873 | 2 069 | 403 | 1 307 | 4 153 | 24 237 | 126 872 | 839 |
| Madhya Pradesh | 9 015 | 6 091 | 2 118 | 1 860 | 2 557 | 1 965 | 838 | 852 | 1 036 | 1 008 | 2 057 | 5 400 | 2 251 | 0 |
| Uttar Pradesh | 11 828 | 17 704 | 6 056 | 4 431 | 3 914 | 11 651 | 2 195 | 899 | 998 | 4 862 | 10 400 | 34 444 | 36 959 | 293 |
| West Bengal | 1 768 | 12 417 | 3 815 | 1 624 | 1 990 | 1 446 | 1 453 | 1 275 | 374 | 217 | 4 753 | 18 486 | 11 094 | 124 |
| Total | 55 595 | 83 423 | 40 265 | 33 402 | 32 616 | 84 902 | 35 179 | 19 281 | 12 773 | 16 190 | 27 407 | 88 114 | 188 003 | 1 436 |

[a] No cases were reported during this period in the union territory of Andaman and Nicobar Islands.
[b] Part of Assam.
[c] Part of Punjab.

effective the family registers may have been, their use continued in many areas until the late 1960s.

The proportion of the population found to have been successfully vaccinated was less than the reported 80% in all districts, ranging from 54% to 73%. Substantially lower levels of vaccination coverage were found in urban districts than in rural areas. Although the numbers reported to have been vaccinated were probably somewhat inflated, the more basic problem was similar to that observed in New Delhi: the most accessible individuals—schoolchildren, for example—were being vaccinated as often as every 6 months, while pre-school children and persons in the lowest socio-economic groups, among whom smallpox was most prevalent, were not being vaccinated at all.

In areas which had entered the maintenance phase of the programme, the National Institute's teams evaluated performance by examining children aged 3–12 months for the presence of a vaccination scar. After the mass campaign, all children on reaching 3 months of age were supposed to be vaccinated by staff assigned to the local primary health centre. In one district, 88% of children 3–12 months old had vaccination scars, but in the remaining districts the corresponding proportions were, respectively, 2%, 9%, 23% and 38%. The National Institute's teams investigated reported cases of smallpox in the maintenance phase areas and in each district they found many other cases which had not been detected.

In view of the fact that the districts evaluated were among the few which had reported that they had achieved the target of 80% coverage, it was apparent that the programme had fallen far short of expectations. An internal document issued by the United States Agency for International Development in November 1964, justifying the programme's continued use of United States rupee funds, stated prophetically: "Eradication of smallpox in India ... is at least 10 years hence ..."

Despite the extensive vaccination programmes, 30 000–40 000 cases of smallpox were reported each year during 1964–1966 (Table 15.3). Because millions had been rendered immune through vaccination, a decrease in the true incidence of the disease is assumed to have occurred, although such a decrease might have been masked by a more complete notification of cases. However, no specific measures had been taken to improve the reporting system and little is known about its efficacy at this time beyond the recognition that only a small proportion of cases was officially recorded.

Serious deficiencies extended throughout the reporting network at each level responsible for data collection and transmission. In villages, cases of smallpox, as well as of plague and cholera, were supposed to be reported to the primary health centre by the village headman in most states or, in some, by the village watchman (chowkidar)—a poorly paid, sometimes illiterate employee of the village council. Some villages submitted reports but many did not. Health workers, assigned to primary health centres, paid little attention to the reporting of smallpox.

An additional problem was that villagers sometimes deliberately hid cases to avoid vaccination, to which they objected for religious reasons or because they feared the painful, infected lesions which so often resulted from the use of the rotary lancet. Some persons who had contracted the disease concealed themselves to avoid being taken forcibly to congested and understaffed hospitals. The cases that came to the attention of primary health centre personnel and district officials were frequently not reported by them to higher authorities because they were afraid of being punished by their supervisors. Many supervisory staff acted on the premise that the occurrence of cases in an area was prima facie evidence that the health staff had done an inadequate job of vaccinating the population and so deserved punishment.

At that time, the Central Bureau for Health Intelligence, the national statistical office, simply recorded data, showing little interest in whether the districts and states reported at all. Even the simple task of recording data was confounded by a system, unique to India, which required each district to report each week the number of cases detected according to the week of onset of the cases. This differed from the practice in other countries, in which a weekly report was compiled giving the number of cases of smallpox *detected* that week, irrespective of the date of onset. Thus, instead of receiving and recording one number for each of India's 393 districts, the Central Bureau received new reports of cases for each district extending back weeks or even months. All numbers were entered in a great ledger, past numbers corrected and new

### Vaccination Using the Rotary Lancet

Until the bifurcated needle began to be used in 1970, vaccination was an elaborate and time-consuming ritual. Each vaccinator had a helper who carried a vaccination bag, and the pair proceeded from house to house to identify individuals to be vaccinated. When a candidate was found, the helper unpacked the bag and the following routine, prescribed by the Directorate of Health Services, was followed (India, Ministry of Health and Family Planning, 1966):

1. Check your kit bag to make sure that all the articles are there.
2. Perform vaccinations in a shady place to prevent exposure of the lymph to the sun.
3. Before vaccinating a person, wash your hands thoroughly with plain soap and water.
4. Sterilize both the scoop end and the toothed end of the rotary lancet in water brought to the boil beforehand and kept boiling. Hold the middle of the lancet with your thumb and index finger and dip the two ends in boiling water alternately for a minute each. If quick work is required, hold the two ends of the rotary lancet alternately over a naked flame. After sterilizing the lancet, keep it on a special wooden stand, taking care to see that the two sterilized ends do not come into contact with any other object.
5. Scrub the site chosen for vaccination thoroughly with plain soap and water. Wipe it dry with a sterile swab.
6. Take the vaccine tube from the ice container, unscrew its cap, take the lymph on the scoop end of the rotary lancet, recover the tube and put it aside on a special holder. Place the lymph on the required number of spots, on the outer surface of the middle third of the left upper arm for primary vaccinations, and on the front surface of the left forearm for revaccinations. Place the toothed end of the lancet on the skin through the drop of lymph. Rotate the lancet with gentle and even pressure so as to produce a light circular cut without drawing blood. After making the insertion, rub in the lymph into the scarified area with the scoop end of the lancet. Detain the person for 15 minutes so that the lymph may have time to get absorbed into the skin.

After one or several vaccinations had been performed at a house, the bag was repacked by the helper, and the vaccinator and helper proceeded to the next house.

Vaccinators who failed to permit the lancet to cool sufficiently or who were were too vigorous in pressing it into the skin inflicted painful lesions. Because the lancets were often contaminated, the vaccination lesions frequently became septic. The scars which remained sometimes resulted from the growth of vaccinia virus but sometimes were caused by bacterial infection alone. Not surprisingly, many vaccinators were offered money *not* to vaccinate.

Given the routine and the need to record the name of each vaccinee in a large register, it was unusual for a vaccinator to perform more than 25 vaccinations a day. When the bifurcated needle became available, the procedure was greatly simplified and both the special bags and the helpers gradually disappeared. However, the pace of vaccination, by then well ingrained, did not substantially increase.

totals compiled. Similar procedures were followed by district and state statistical offices. However, many of these offices did not forward reports of cases which had occurred several weeks or months previously, considering them not to be of current interest.

The National Smallpox Eradication Programme Advisory Committee held a meeting in November 1965 to decide what should be done when, in March 1966, the attack phase—the mass vaccination campaign—was scheduled to be completed and the programme throughout the country would enter its maintenance phase (India, Ministry of Health and Family Planning, 1966). The Director of the National Smallpox Eradication Programme, Dr K. M. Lal, expressed optimism that there would be a "further steep fall" in incidence in 1966–1967 but was concerned about the large number of persons who still remained unvaccinated. Because

independent assessments had shown that equating the numbers of recorded vaccinations with the numbers of persons successfully vaccinated was erroneous, it had been decided that a target of 100% vaccination coverage was necessary (a strategy endorsed by a WHO Expert Committee on Smallpox (1964) at Dr Lal's suggestion). Dr Lal doubted that a satisfactory maintenance vaccination programme could be conducted by the existing primary health centre staff, malaria workers, midwives and others. The 1963–1964 assessment had shown this. He favoured a plan which had been suggested to and approved by the Advisory Committee in 1963, whereby 1 smallpox vaccinator would be provided for every 10 000–15 000 persons in rural areas and for every 20 000 persons in urban areas. Such a scheme would be costly and, by any standard, would involve a generous deployment of manpower. Assuming that a vaccinator worked 200 days a year, he could theoretically vaccinate the entire population in a rural area during the space of a year by performing as few as 50–75 vaccinations a day.

Dr Lal and many members of the Advisory Committee were reluctant to end the attack phase with its mass vaccination units until cases had ceased to occur in a district. Various members proposed intervals of up to 3 years as the desirable time for an area to be smallpox-free before it entered the maintenance phase and vaccination was turned over to basic health staff or local body vaccinators. A special subcommittee was appointed to explore the question further. However, budgetary considerations intruded. The government was forced to decrease expenditure, and the attack phase programme, with its 152 mass vaccination units, was terminated. Special vaccinators for smallpox continued their work in most areas, but in a few, a handful of poorly trained and poorly supervised basic health workers were expected to add vaccination to other tasks.

Meanwhile, vaccine production institutes at Patwadangar, Belgaum, Guindy (Madras) and Hyderabad struggled unsuccessfully to produce the large quantities of freeze-dried vaccine required. By 1966–1967, they were producing only 1.4 million vials (enough to vaccinate about 20 million people). The USSR continued to provide approximately 500 000 vials each month, but even this was not enough. Emergency requests to other governments were regularly channelled through WHO, and several million additional doses were received from the Netherlands, Switzerland and the United Kingdom, but none of these sources could supply substantial quantities since none had laboratories equipped for the large-scale production required. Accordingly, the thermolabile, questionably potent, liquid vaccine continued to be used in a number of states since it was felt that unsatisfactory vaccine was better than no vaccine at all.

Table 15.4. India: numbers of reported vaccinations, percentages relative to population, and numbers of reported cases of and deaths from smallpox, 1962–1976

| Year | Primary vaccinations | | Total vaccinations | | Reported number of cases of smallpox | Reported number of deaths from smallpox |
|---|---|---|---|---|---|---|
| | Number | % relative to population[a] | Number | % relative to population[a] | | |
| 1962 | 3 520 000 | 0.8 | 32 350 000 | 7.2 | 55 595 | 15 048 |
| 1963 | 16 350 000 | 3.6 | 138 720 000 | 30.2 | 83 423 | 26 360 |
| 1964 | 15 400 000 | 3.3 | 130 380 000 | 27.7 | 40 265 | 11 831 |
| 1965 | 17 390 000 | 3.6 | 109 840 000 | 22.8 | 33 402 | 9 058 |
| 1966 | 17 230 000 | 3.5 | 83 000 000 | 16.8 | 32 616 | 8 482 |
| 1967 | 18 560 000 | 3.7 | 96 450 000 | 17.2 | 84 902 | 26 225 |
| 1968 | 22 000 000 | 4.3 | 83 000 000 | 16.1 | 35 179 | 7 266 |
| 1969 | 22 700 000 | 4.3 | 76 870 000 | 14.6 | 19 281 | 4 156 |
| 1970 | 23 060 000 | 4.3 | 77 110 000 | 14.4 | 12 773 | 2 240 |
| 1971 | 24 190 000 | 4.4 | 91 680 000 | 16.7 | 16 190 | 2 706 |
| 1972 | 26 950 000 | 4.8 | 112 730 000 | 19.6 | 27 407 | 5 457 |
| 1973 | 24 840 000 | 4.4 | 112 340 000 | 19.8 | 88 114 | 15 434 |
| 1974 | 24 180 000 | 4.2 | 123 430 000 | 21.3 | 188 003 | 31 262 |
| 1975 | 19 025 474 | 3.2 | 86 718 634 | 14.6 | 1 436 | 176 |
| 1976 | 16 745 086 | 2.8 | 66 854 231 | 11.1 | 0 | 0 |

[a] The percentages provide an index of vaccination activity and are derived by dividing the reported total number of vaccinations performed by the estimated total population (from Basu et al., 1979). The figures do not provide a measure of the proportion of the population newly immunized or whose immunity was boosted. Vaccination was sometimes unsuccessful and some individuals were vaccinated two or more times in a year. Moreover, the reported total numbers of vaccinations performed were sometimes inflated.

The Herculean effort to eradicate smallpox through mass vaccination, launched so enthusiastically in 1962, had all but come to a halt by the time the Nineteenth World Health Assembly, in May 1966, decided to embark on the Intensified Smallpox Eradication Programme. The Indian delegate to the Health Assembly, commenting on the new initiative, pointed out that India would need 180 million doses of vaccine annually, of which it would never be able to produce more than 60 million doses, and expressed the hope that WHO could meet the projected deficit. He cautioned the delegates that unless good basic health services were developed "it would be very difficult indeed to maintain the immunological status temporarily reached" in a mass campaign (World Health Organization, 1966c).

In December 1966, Henderson, who had recently been appointed Chief of the newly constituted Smallpox Eradication unit at WHO Headquarters, arrived in New Delhi to participate in his first intercountry smallpox eradication seminar, attended by representatives from countries in WHO's South-East Asia Region. It was not an auspicious beginning, as India, which then accounted for one-third of the world's cases, announced at the seminar that it had terminated its attack phase and had reverted to a programme of maintenance vaccination.

## The Intensified Smallpox Eradication Programme Begins, 1967

The advent of the Intensified Programme in India found a discouraged staff. Dr Lal, the director of the National Smallpox Eradication Programme since 1962, retired and, because the attack phase had been terminated, was not replaced. This left at the national level only one medical officer, Dr Mahendra Singh, a Deputy Assistant Director-General of Health Services. Although he was overwhelmed by the tasks of giving some sort of direction to the remaining smallpox control activities and of providing the necessary reports to Parliament—among many other duties—Dr Singh tried valiantly to stimulate the host of vaccinators distributed across India. He dispatched numerous cables and letters asking state health directors to take action to control epidemics reported officially to him or, as often, through the press. Vaccination targets were established for each state and those who failed to meet their goals were given forceful reminders. The number of reported vaccinations diminished, however, from 139 million in 1963 and 130 million in 1964 to 96 million in 1967 (Table 15.4). Vaccine distribution was also Dr Singh's responsibility, and a continuing problem because reserves were few and requests to replenish vaccine stocks in state and district offices were often not forthcoming until supplies had been exhausted. Government regulations required that Dr Singh should travel by train or bus, often a 1- or 2-day trip to reach distant and populous state capitals. In each state, there was only one official responsible for smallpox, and he was usually assigned responsibility for one or more additional programmes. The smallpox eradication programme and its still extensive complement of vaccinators laboured under a severe shortage of senior, responsible staff.

## Assessment of the Programme in India, October 1967

In 1967, smallpox incidence rose dramatically, eventually reaching a total of 84 902 cases, more than had been reported in any year since 1958. Concerned by this turn of events, the Indian government agreed that a joint India–WHO assessment team should


**Plate 15.2.** Medical officers at a primary health centre in Maharashtra State. *Right*: Mahendra K. Singh (b. 1928), a Deputy Assistant Director-General of Health Services, who was the only medical officer at the central level in India's National Smallpox Eradication Programme from 1966 to 1972 and sustained the momentum of the work until additional senior Indian and WHO staff could be assigned. He continued with the programme until the eradication of smallpox in India had been certified in 1977 and was later appointed Director of the Central Bureau of Health Intelligence.

appraise the situation and suggest how it might be rectified. The team's operations were planned and organized by Dr Jacobus Keja, the adviser on smallpox eradication in WHO's South-East Asia Region, and by Dr Singh. In India, an assessment such as this, in which WHO staff travelled to the field, was an uncommon event at that time. Most WHO advisers remained in New Delhi or occasionally visited the more populous state capitals, in which hotels were plentiful. When preparations were being made for the trip, it was discovered that the regional office had in its stores none of the commonly used Indian bedrolls that were needed when travellers stopped at government rest-houses.

The assessment team, comprising 8 senior national health officers and 8 WHO staff and consultants, spent 6 weeks in the field, from 8 October to 19 November. They visited Maharashtra and Uttar Pradesh, two states experiencing epidemic smallpox in 1967, as well as Punjab in the north-west, a state with moderate incidence, and the southern state of Tamil Nadu. The last of these states was of particular interest because of the very few cases reported (263 in 1967) among its population of nearly 40 million.

The observations made by the team are telling, as they provide an overview of the status of smallpox and of the programme in 1967. The team concluded that the programme "is still far from achieving its objective of smallpox eradication in most areas and ... in fact, a very considerable epidemic potential exists in India at the present time." The conclusions of its report are paraphrased below:

*Supervision and direction*

● The functions and responsibilities of the National Smallpox Eradication Programme from the central level to the periphery are fragmented among a variety of independent and semi-independent organizations. There is lack of clarity and definition of responsibilities and objectives at all administrative levels.

● The *central directorate* is inadequately staffed and has no effective mechanism for exercising clear guidance and direction of the programmes at state and local level. Its functions are limited to the collection from the states of inadequate data regarding smallpox incidence and the number of vaccinations performed, the distribution of imported freeze-dried vaccine, the occasional organization of meetings of state and local programme directors, the distribution of some health education material and liaison with international organizations.

● The *states* exhibit a great variation in organizational structure. In many, responsibility for the programme is given to a senior officer burdened with many additional responsibilities. With few exceptions, the state directorates act merely as channels for funding, the transmission of instructions and the receipt of periodic reports from the districts.

● In the *districts*, the district health officer has overall responsibility for the programme as one of many responsibilities. Although as many as 3 paramedical personnel act as assistants, field visits are infrequent, supervision is poor, morale is low, interest in the programme is fading and vaccine is improperly handled and stored. Vaccinators are superintended partly by local administrative bodies and municipal boards and partly by the district staff.

*Programme execution*

● *Legislation* regarding compulsory vaccination varies widely. In some states both primary vaccination and revaccination are required, while in others vaccination is not compulsory. The laws governing enforcement involve cumbersome procedures, and fines are minimal and rarely imposed.

● The *plan* calls for the vaccination of all newborn infants and other individuals not

Table 15.5. India: vaccinator productivity and salary costs per vaccination performed, 1967

| | Number of blocks studied | Number of vaccinations performed per vaccinator per day (range) | Cost per vaccination[a] in rupees (range) |
|---|---|---|---|
| State: | | | |
| Maharashtra | 10 | 6.3 (0.5–11.3) | 2.42 (13.9–0.48) |
| Punjab | 8 | 5.7 (0.1–12.7) | 3.17 (13.2–0.42) |
| Tamil Nadu | 11 | 24.5 (6.4–51.6) | 0.49 (1.04–0.16) |
| Uttar Pradesh | 19 | 11.4 (3.1–37.2) | 0.94 (8.71–0.20) |
| Municipality: | | | |
| Bombay | | 14.3 | 0.47 |
| Madras | | 8.5 | ..[b] |

[a] Salary costs only—i.e., not including costs of vaccine, supervision, supplies or transport. (In 1967, 1 rupee was equivalent to US$0.13.)
[b] .. = data not available.

previously vaccinated and the revaccination of everyone every 3 years; it also requires an assessment of "takes" among all primary vaccinees and 50% of revaccinees, as well as entry in the family registers of actions taken. The team concludes that none of the targets is being reached and that records are being falsified in most areas visited.

- The number of *vaccinators* is high (ranging from 1 for every 26 000 persons in Maharashtra to 1 for every 31 000 in Uttar Pradesh) but productivity is low [Table 15.5]. The mean number of vaccinations performed per day ranges from 5.7 in Punjab to 24.5 in Tamil Nadu, but in some blocks the average is less than 1 vaccination per day. Vaccinator salary costs alone average 0.47 rupee (US$0.06) per vaccination, but in 3 blocks they exceed 7.5 rupees (US$0.98) per vaccination.
- *Supervision*, except in Tamil Nadu, consists primarily in determining whether or not the vaccinator reports for work.
- *Vaccine* is improperly stored, inventories are inaccurate and refrigerators are frequently lacking or not in working order.
- The number of *reported cases* is estimated to be no more than 10% of the actual number and notification is considerably delayed except in Tamil Nadu, in which reporting appears to be reasonably complete. Many cases which are officially notified to state authorities are not subsequently reported to the national authorities. This deficiency in notification is illustrated by the situation in Punjab, in which state records to date in 1967 showed 1370 cases, of which only 273 had been notified at the national level.
- *Containment* measures are insufficient. For example, in a village in Uttar Pradesh, with a population of 250, 20 cases occurred; after containment, it was found that 20% of the unaffected children remained unvaccinated.
- Contrary to the findings of other reports, *vaccination acceptance* is good and the number of refusals for religious reasons is negligible. For the most part refusals stem from the unwillingness of people to be vaccinated at a time when a serious reaction might interfere with occupational responsibilities. Contributory factors are the tactlessness of some vaccinators, a crude vaccination technique and failure to inform people of the importance of vaccination. The rotary lancets waste vaccine (15 vaccinations are obtained from a vial of 0.25 ml compared with the 25–50 vaccinations obtained when the scratch technique is used); the lancets are difficult and time-consuming to sterilize and produce unusually severe local reactions.
- *Vaccination take rates* are said to be 100%, but assessment from records was possible only in Bombay. The records there show a take rate of 99.7%, but, in fact, failures were being recorded only after 3 unsuccessful attempts. The records show a maximum take rate of 77% after a single vaccination but it is probable that the actual take rate is considerably lower.
- The *family registers* everywhere are incomplete and contain numerous errors. They have been abandoned in Uttar Pradesh; in the Punjab and Maharashtra, in which a serious effort is being made to use them, vaccinators spend more than half their time on keeping them up to date.

*Levels of achievement*

- Smallpox incidence, the ultimate yardstick for measuring success, is noted to be rising. The total number of cases by the end of 1967 will represent the greatest incidence to be recorded in a decade. Even so, this total will represent 10% or less of the actual incidence.
- Cases are occurring in all age groups, although two-thirds or more in the states assessed are found in individuals under 15 years of age [Table 15.6].
- The proportion of the population reported to be receiving primary vaccination each year is less than 4% in all 4 states. With an estimated birth rate of 4% and many children born in previous years remaining unvaccinated, it is apparent that the number of susceptible subjects is accumulating.
- Sample surveys conducted among individuals under 15 years of age in randomly selected districts of the 4 states and wards of the cities of Madras (Tamil Nadu) and Bombay (Maharashtra) reveal widely different levels of performance [Table 15.7]. Uttar Pradesh has a higher proportion of unvaccinated children than was found in a survey conducted 10 years ago. In contrast, 90% of those in Tamil Nadu and 87% of those in the Punjab have vaccination scars. Vaccination levels in Madras and Bombay are substantially better than in the non-urban areas, a result attributed, in part, to the vaccination of children at birth (nearly 80% of them are born in hospital).

The team offered a detailed series of recommendations prefaced by the statement: "The Central Government should develop a new and long-term strategy to meet the

Table 15.6. India: age distribution of cases of smallpox in 4 states, 1967

| Age group (years) | Maharashtra | Punjab | Tamil Nadu[a] | Uttar Pradesh |
|---|---|---|---|---|
| <1 | 12% | 10% | 10% | 16% |
| 1–4 | 45% | 21% | 32% | 30% |
| 5–14 | 32% | 33% | 23% | 35% |
| ⩾15 | 11% | 36% | 35% | 19% |
| Number of cases | 100 | 418 | 4 329 | 158 |

[a] Data pertain to 1965–1967.

Table 15.7. India: results of vaccination scar surveys in children in 4 states and 2 municipalities, by age group, 1967

| | Number of districts or wards surveyed | <1 year | | 1–4 years | | 5–14 years | | All |
|---|---|---|---|---|---|---|---|---|
| | | Number examined | % with scar | Number examined | % with scar | Number examined | % with scar | % with scar |
| State: | | | | | | | | |
| Maharashtra | 5 | 609 | 38 | 1 612 | 77 | 2 122 | 90 | 79 |
| Punjab | 5 | 785 | 48 | 2 622 | 88 | 3 151 | 96 | 87 |
| Tamil Nadu | 5 | 406 | 39 | 1 553 | 93 | 2 038 | 99 | 90 |
| Uttar Pradesh | 9 | 897 | 10 | 3 428 | 56 | 4 824 | 85 | 69 |
| Municipality: | | | | | | | | |
| Bombay | 5 | 383 | 69 | 1 034 | 90 | 1 132 | 96 | 89 |
| Madras | 6 | 465 | 73 | 1 620 | 97 | 2 196 | 99 | 95 |

problem." In brief, it recommended that greater emphasis should be given to case detection and the containment of outbreaks, especially during the summer months, when the incidence was lowest; and that primary vaccination, including the vaccination of newborn infants, should be given priority. An increase in the personnel complement of the national directorate from 1 to 5 professionals and a concomitant extension of their scope of responsibility were also recommended, along with the strengthening of supervision at all other administrative levels. It was suggested that vaccine production should be centralized and financed under national rather than state authority, that the use of liquid vaccine should cease throughout India, that the bifurcated needle should replace the rotary lancet, and that the family registers should be abolished.

## Progress Achieved in the Programme, 1968–1970

The recommendations of the joint assessment team were basically sound but smallpox eradication was not high among the government's priorities. Nevertheless, over the succeeding 3 years, the production of freeze-dried vaccine increased and its quality was improved, many laboratories producing liquid vaccine were closed, the bifurcated needle was introduced, the number of primary vaccinations increased, the vaccination of newborn infants was initiated in several areas, and in some states effective surveillance–containment programmes were conducted.

### *Vaccine and the vaccination programme*

On the basis of WHO recommendations, Dr Singh stressed in a number of directives the importance of primary vaccination, and, as from 1968, the proportion of the population reported to have been given primary vaccination increased significantly (see Table 15.4). However, even with the increase, this proportion barely exceeded the birth rate. At the same time, the total number of reported vaccinations declined steadily.

The vaccination of infants at birth was recommended as a national policy. Traditionally, primary vaccination in India had been deferred until children reached at least 3 months of age. Studies begun in 1959 by Dr A. R. Rao in Madras showed that the vaccination of neonates was safe and that systemic symptoms were minimal (Rao & Balakrishnan, 1963). With the liquid vaccine then in use, 80% were successfully vaccinated but, when freeze-dried vaccine and the bifurcated needle became available, this rate rose to more than 95%. It was clear that if vaccinators could vaccinate all children whom they encountered, overall vaccinial immunity would be enhanced. Equally important, higher levels of vaccinial immunity could be achieved in large urban areas, where 75–80% of women were delivered in a hospital or nursing home. Because the high concentration of people in urban areas played an important role in sustaining smallpox transmission, it was hoped that routine vaccination of newborn children in cities might have a significant impact in diminishing incidence throughout the country.

The routine vaccination of neonates began in Madras and Bombay in 1967 and in several other cities of Tamil Nadu in 1968. However, the practice was not enthusiastically pursued in most areas, partly because of the lack of interest shown by the autonomous municipal health officers and partly because mothers were reluctant to let their babies be vaccinated. They had observed in other children

the severe lesions induced by the rotary lancet and had had no opportunity to see the results of vaccination with the bifurcated needle.

From 1968 to 1970, efforts were made to increase the volume and quality of vaccine produced in India and to improve the distribution system and storage of the product. In 1969 the government appointed a central director for vaccine production and distribution, Dr S. N. Ray, and the following year, the 4 vaccine production centres were placed under central government authority and financed by central government funds rather than state funds. This simplified distribution, because vaccine produced in any one of the institutes could then be sent to any state of India without special payments being required. Previously, vaccine produced in each of the state laboratories had been used mainly in that state, while vaccine donated to India, primarily by the USSR, was sent to other states.

Vaccine production in India gradually increased in volume but less rapidly than had been expected. Not until 1974, in fact, did the country become completely self-sufficient (Table 15.8). In part, the delays could be attributed to preoccupation on the part of the director of the Patwadangar laboratory, the principal production laboratory, with the introduction of comparatively new, more elaborate machines for freeze-drying—the so-called shelf-driers. Relatively simple centrifugal freeze-driers were then in use in many countries and when installed in competent laboratories, as in Indonesia and Kenya for example (see Chapter 11), could be used at full capacity within a year. The director justified the need for the shelf-driers on the grounds that extremely large quantities of vaccine would be required, estimating the need for far greater amounts than had been used during the 1962–1966 mass vaccination campaign. Moreover, he argued that the bifurcated needles, although they used less vaccine and had been adopted in most other countries, would never be acceptable in India. WHO smallpox eradication programme staff, however, foresaw the need for smaller quantities of vaccine, especially if the bifurcated needles could be used, and argued for the purchase of the less complex centrifugal driers. After an impasse lasting almost a year, a staff member of the WHO regional office, who was responsible for providing advice to laboratories, gave approval for the purchase of the shelf-driers, although he himself was not competent in vaccine production. With the promise of purchase of the shelf-driers, the laboratory director gave approval for studies of the bifurcated needle to be undertaken in India (see below). As had been feared, the shelf-driers proved difficult to operate and production increased only slowly but, because of the introduction of the bifurcated needle and the continued provision of vaccine by the USSR, vaccine shortages did not occur.

With an assured supply of freeze-dried vaccine available throughout India, it became possible for the government to insist on the cessation of production of the thermolabile

Table 15.8. India: number of ampoules[a] of freeze-dried vaccine produced each year, 1962–1977, by vaccine production centre, and donated vaccine distributed, 1970–1974

| Years | Patwadangar | Belgaum | Guindy (Madras) | Hyderabad | Total | Donated vaccine[b] |
|---|---|---|---|---|---|---|
| 1962–1963 | 38 368 | 0 | 0 | 0 | 38 368 | .. |
| 1963–1964 | 87 121 | 0 | 609 | 0 | 87 780 | .. |
| 1964–1965 | 480 208 | 0 | 5 418 | 0 | 485 626 | .. |
| 1965–1966 | 1 202 296 | 0 | 212 565 | 0 | 1 414 861 | .. |
| 1966–1967 | 858 889 | 172 000 | 380 639 | 0 | 1 411 528 | .. |
| 1967–1968 | 959 931 | 620 155 | 557 867 | 173 685 | 2 311 638 | .. |
| 1968–1969 | 1 188 680 | 1 123 031 | 852 667 | 401 827 | 3 566 205 | .. |
| 1969–1970 | 1 077 385 | 812 383 | 470 000 | 466 759 | 2 826 527 | .. |
| 1970–1971 | 829 054 | 498 337 | 1 114 000 | 244 657 | 2 686 048 | 1 823 000 |
| 1971–1972 | 1 185 385 | 1 164 037 | 792 662 | 381 434 | 3 523 518 | 1 650 000 |
| 1972–1973 | 2 765 181 | 1 447 573 | 1 204 684 | 442 398 | 5 859 836 | 2 100 000 |
| 1973–1974 | 4 054 862 | 2 317 641 | 1 627 417 | 807 542 | 8 807 462 | 1 300 000 |
| 1974–1975 | 3 298 075 | 3 174 857 | 1 886 277 | 1 065 035 | 9 424 244 | 0 |
| 1975–1976 | 2 853 113 | 1 908 252 | 1 721 082 | 691 073 | 7 173 520 | 0 |
| 1976–1977 | 1 545 918 | 1 888 716 | 1 628 057 | 569 657 | 5 632 348 | 0 |

[a] With the rotary lancet, the contents of 1 ampoule were required to vaccinate 12–15 persons. When the bifurcated needle was used, the same quantity of vaccine sufficed to vaccinate as many as 100.

[b] The USSR donated from 5 to 6 million ampoules of vaccine annually beginning in 1962, but data regarding the distribution of this vaccine are not available before 1970–1971.

liquid vaccine. However, closure of the 14 state institutes which produced it proved to be difficult. The central government lacked the necessary authority; one by one, each state and centre had to be visited by officials of the central government and persuaded to cease production. This was finally accomplished in 1970, the last centres being in Calcutta and the eastern states. Even after closure of the production centres, however, problems remained. In several states, the stocks of liquid vaccine occupied all the available refrigerated storage space and, without the sanction of the finance department to destroy the vaccine, programme officers could take no action. Accordingly, in several areas, including Bihar State, in which smallpox was eventually to prove a major problem, stocks of freeze-dried vaccine continued to be stored at room temperature while the obsolete liquid vaccine was kept under refrigeration.

The provision of satisfactory refrigerated storage for vaccine was a continuing problem in other areas as well. The freeze-dried vaccine was supposed to be kept at ambient temperature for not more than 30 days but could be stored almost indefinitely at temperatures of 4 °C or less. Because, for reasons of logistics, most vaccinators could obtain vaccine supplies only once a month, it was important to ensure that vaccine stored in district offices, as well as in the state and national depots, was kept under refrigeration. Satisfactory storage at state and national distribution centres was gradually achieved through the provision of refrigerators by UNICEF and WHO and through the use of other facilities such as cold-rooms normally used for the storage of fruit and vegetables. In the districts, however, satisfactory storage was uncommon. Although virtually all district offices were provided with refrigerators for the storage of drugs and vaccines for a variety of programmes, few were maintained in working order. For example, as late as 1975, 85% of the refrigerators in district offices in Uttar Pradesh were found to be inoperative. Fortunately, as tests of vaccine showed, much of the vaccine produced in the USSR and India maintained levels of potency adequate for primary vaccination even after 3–4 months at high ambient temperatures (Sehgal, 1974; Sehgal & Ray, 1974).

The assessment team had also recommended that at least one-third of all batches of vaccine produced and tested in the separate laboratories should be independently tested by a national vaccine control laboratory and that the results should be confirmed by a WHO smallpox vaccine reference centre (National Institute of Public Health, Bilthoven, Netherlands). In 1969, an Indian central control laboratory was established at the National Institute of Communicable Diseases, New Delhi, although it was not until 1972 that the laboratory actually monitored the recommended number of batches. In 1969, some batches of vaccine also began to be sent to the WHO reference centre for testing. During the period 1969–1976, of the 241 batches tested by WHO only 9 (3.7%) were found to be substandard (Basu et al., 1979). Although these data would suggest a consistently high level of satisfactory production, it must be noted that all batches dispatched to WHO had been determined, first by the production laboratory and then by the central control laboratory to be completely satisfactory. The producers and the central testing laboratory found a much higher proportion of batches of vaccine to be of inferior potency or stability or unacceptably contaminated with bacteria. Some such batches were destroyed but, in the first few years, most were distributed anyway because vaccine was in short supply. Properly, it was considered preferable to use substandard freeze-dried vaccine than to use liquid vaccine or to have no vaccine at all. No compilation of data on vaccine quality is available, but it was known that the Hyderabad and Guindy laboratories both had persistent difficulties in producing satisfactory vaccine. However, together they accounted for less than one-fifth of all vaccine distributed in India and most of the vaccine they produced was distributed to states in southern India in which health services were generally better and smallpox incidence was lower.

The improved quality of vaccine and a better storage system undoubtedly resulted in a higher proportion of successful vaccinations in the field, although no data are available to substantiate this.

### *Introduction of the bifurcated needle*

The bifurcated needle had been tested by WHO in late 1967 and early 1968 and was rapidly made available throughout most countries by the middle of 1968. In India, however, the traditional rotary lancet had

been in use since before the turn of the century and a number of prominent senior health authorities as well as the director of the vaccine production laboratory in Patwadangar resisted the introduction of the new instrument. They argued that it would produce fewer successful vaccinations, that vaccinators would find it too difficult to use, and that the population would resist vaccination with an unfamiliar device. Finally, it was agreed that comparative studies of the two instruments would be undertaken by the National Institute of Communicable Diseases and the Central Health Education Bureau (WHO/SE/70.16).

In 1969, the National Institute assessed the efficacy of the two techniques (Pattanayak et al., 1970). In one study, previously vaccinated children were vaccinated on one arm with the rotary lancet and on the other arm with the bifurcated needle. Vaccines of three different levels of potency were employed. The results showed that the bifurcated needle had a clear-cut advantage over the rotary lancet (Table 15.9).

Comparative data derived from a study of a small number of children given primary vaccination showed similar results. It was found that vaccinators readily learned the new technique and used it successfully.

During the same period, the Central Health Education Bureau investigators assessed the acceptability of the new technique, with surprising results. Persons in 5 villages were vaccinated with the bifurcated needle, but they were given no explanation about the new device. One week later, the vaccinees were examined to determine the proportion with successful vaccinations and were interviewed about the new technique. All those given primary vaccination, and 79% of those who had been revaccinated, had successful takes. As the investigators noted, "surprisingly, few realized that the technique applied was different from the customary rotary lancet method" (WHO/SE/70.16). With these results, the needle was accepted by the national health authorities for use in India.

Needles were provided by WHO in large numbers and, by late 1969, they were in wide use in many states. However, the adoption of the new technique required that a decision should be taken separately by each state and municipality, and some were not persuaded. Not until 1971, for example, were the needles used in the states of Uttar Pradesh and Bihar. In many municipalities, vaccinators continued to use the rotary lancet until late 1973, when municipal smallpox eradication staff were brought under state jurisdiction.

The use of the bifurcated needle, however, brought a curious and unforeseen administrative problem. Auditors in India continually scrutinized the number of vaccinations performed in an area and compared it with the number of vaccinations reported in order to detect wastage. The vials of vaccine containing 0.2 ml allowed for only 15 vaccinations if the rotary lancet was used. With the bifurcated needle as many as 100 vaccinations could be performed with the contents of one vial, but in practice, an average of only 40–50 vaccinations was achieved because whatever reconstituted vaccine remained at the end of the day was supposed to be discarded. Although, in fact, more vaccinations were performed per vial supplied, the auditors calculated that each vial should now yield 100 doses of vaccine. Their assertions that vaccine was being wasted were to plague smallpox eradication staff throughout the rest of the programme.

### *Sample surveys to determine vaccination status*

In 1969, the technique for vaccination scar surveys which had been developed in Afghanistan (see Chapter 14) was introduced into India. Through such surveys it was hoped that responsible officials would identify for themselves deficiencies in their vaccination programmes and correct them.

Table 15.9. India: results of simultaneous revaccination of children with the rotary lancet and the bifurcated needle

| Vaccine potency (pock-forming units/ml) | Number of children | Rotary lancet | Bifurcated needle |
|---|---|---|---|
| | | Number (%) with satisfactory response | Number (%) with satisfactory response |
| $1 \times 10^8$ | 84 | 22 (26) | 47 (56) |
| $5 \times 10^7$ | 82 | 10 (12) | 29 (35) |
| $1 \times 10^7$ | 81 | 10 (12) | 26 (32) |

The simplified methodology for scar surveys, using a cluster sample technique, was enthusiastically received in many states and numerous surveys were undertaken, some of which were state-wide. Not all the surveys were well designed, but the results consistently revealed a remarkably high proportion of vaccinated persons. The surveys showed that vaccination scars were borne by 92–99% of individuals in the age group 5 years and above; by 78–92% of those aged 1–4 years; and by 10–60% of infants under 1 year. Although the results were dutifully compiled and reported, few used the data constructively to identify populations or areas in which vaccinial immunity was low and to improve performance in such areas. The idea of assessing vaccination status in this way was reasonable but, in retrospect, the approach was probably counter-productive in that it served to reinforce the notion that mass vaccination was the principal foundation of the programme, rather than surveillance–containment measures.

### *The decline in smallpox incidence*

Between 1967 and 1970, the reported number of smallpox cases fell dramatically—from 84 902 to 12 773, the lowest total ever recorded in India. Both government and WHO staff recognized that this reflected, at least in part, the normal periodic fluctuations of smallpox. Peaks in smallpox incidence in India normally occurred every 4–7 years, a periodicity extending back many decades. The peak in 1967 occurred just 4 years after the peak in 1963, which had been preceded, 5 years before, by the peak in 1958. This pattern was said to occur as a result of the gradual increase in the number of susceptible persons because of the waning of immunity in the population at large and the addition of susceptible newborn children. It was believed that when a sufficient number of susceptible persons had accumulated, an epidemic would ensue which would diminish this pool of susceptible individuals and thus the ease with which smallpox could spread. Following the epidemic, smallpox incidence would again decline. The decrease in the number of reported cases between 1967 and 1970 was thus not unexpected, but because the incidence had fallen to such low levels, some government and WHO staff were both optimistic and, to a certain extent, unduly satisfied with progress in the redirection of the programme. The archaic notification system, with its delays in reporting, only served to reinforce this optimism. By mid-January 1971, for example, only 8026 (63%) of the 12 773 cases eventually recorded for 1970 had been reported to the Central Bureau for Health Intelligence.

### *Southern India, 1967–1970*

The decline in smallpox incidence between 1967 and 1970 was especially notable in the 6 states and 5 union territories which formed the entire southern part of India. This area had a population in 1967 of 196 million (38% of the national total). The number of cases fell from 42 633 in 1967 to only 795 in 1970. Many districts reported no cases in that year (Fig. 15.5) and none was detected in the entire state of Tamil Nadu (population, 41 million) (Table 15.10).

In part, this decline was attributable to a generally more developed health service structure, especially in the states of Kerala and Tamil Nadu and, in consequence, a better execution of the mass vaccination campaign. It was also associated with the development of an effective surveillance–containment programme—first in Tamil Nadu and later in parts of Andhra Pradesh.

To evaluate the applicability of surveillance–containment in India, it was decided in 1968 to investigate and contain all outbreaks in Madras, the capital of Tamil Nadu, and subsequently in the state itself, employing a surveillance team directed by Dr A. R. Rao, then Health Officer of the Madras Municipal Corporation. Support for this operation was provided by the Indian Council for Medical Research and WHO (WHO/SE/68.6 and WHO/SE/68.7, A. R. Rao). Dr Rao, for many years the Director of the Madras Infectious Diseases Hospital, had conducted extensive investigations into the clinical and epidemiological behaviour of smallpox (Rao, 1972). He was an ideal person for the task and interested in taking up the challenge.

Smallpox incidence in Tamil Nadu had declined sharply, from 8901 cases in 1963 to only 263 cases in 1967, of which 38 cases had been reported by the Madras Municipal Corporation. The joint India–WHO assessment team (1967) believed that reporting was better in Tamil Nadu than elsewhere in India and, if indeed there were as few cases as notifications suggested, it should be possible to stop transmission with a comparatively

modest outbreak containment programme. If successful, it would serve as an example for other states in India.

Between January and June 1968, the season of highest smallpox transmission, Dr Rao investigated 13 outbreaks in Madras, which were detected when patients were brought to the hospital or when fatal cases were registered at the burial grounds. The source of 7 outbreaks could be traced, 6 of them coming from adjoining states. Eight of the index cases were hospitalized within 10 days of onset and none of them spread the disease. Five of the infected persons were hidden at home and, before discovery, 8 second generation and 4 third generation cases occurred. However, the total number of cases was small and, as Dr Rao emphasized, smallpox did not spread rapidly in this population despite its high density and the season of the year. In mid-

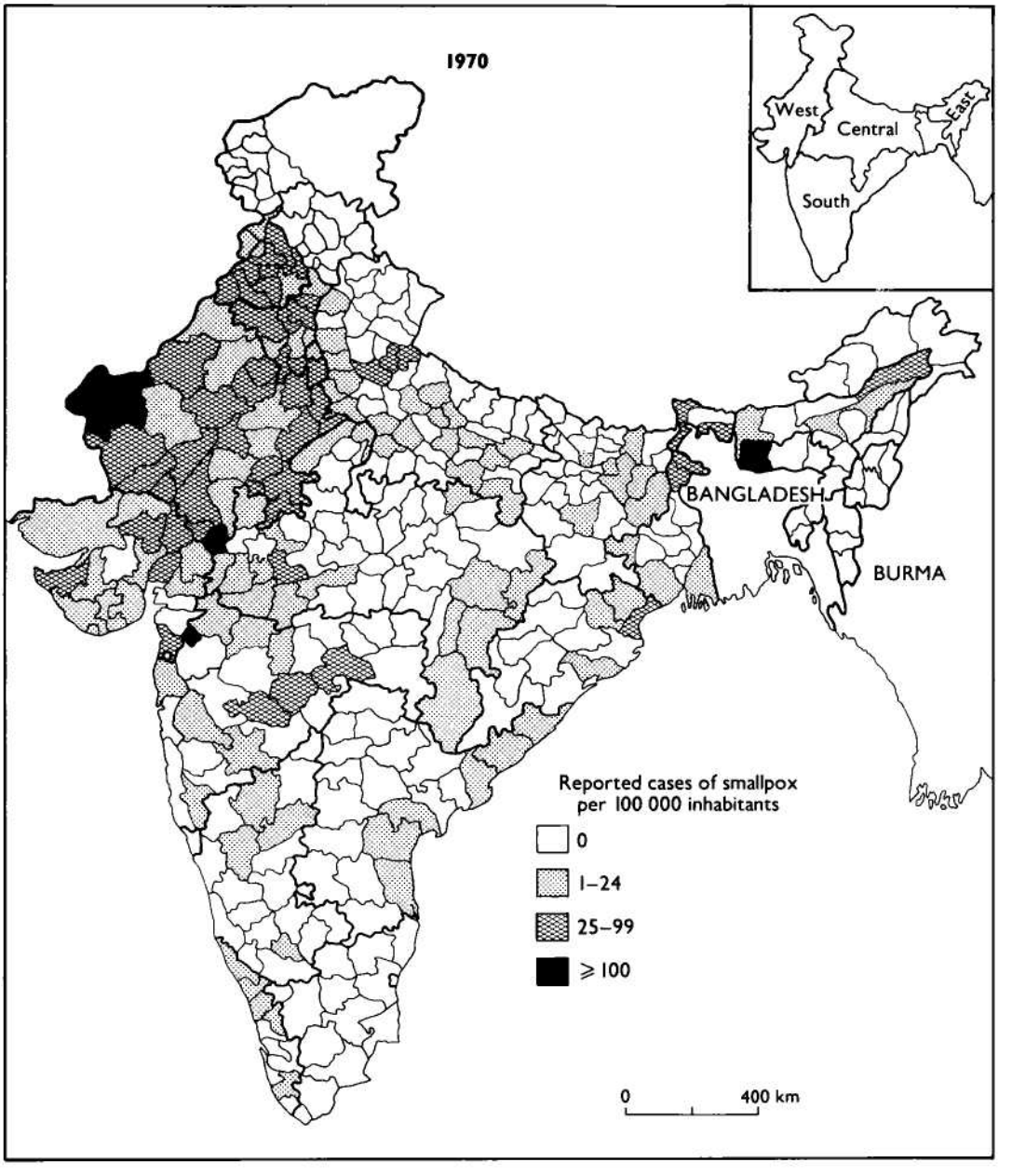


Fig. 15.5. India: number of reported cases of smallpox per 100 000 inhabitants, by district, 1970.

Table 15.10. Southern India: number of reported cases of smallpox, 1967–1970

| State or union territory[a] | 1967 | 1968 | 1969 | 1970 |
|---|---|---|---|---|
| Andhra Pradesh | 8 618 | 7 951 | 1 893 | 358 |
| Dadra and Nagar Haveli | 18 | 2 | 0 | 0 |
| Goa, Daman and Diu | 45 | 18 | 12 | 1 |
| Kerala | 152 | 2 | 9 | 31 |
| Maharashtra | 27 961 | 3 173 | 1 411 | 174 |
| Mysore[b] | 1 770 | 981 | 178 | 126 |
| Orissa | 3 806 | 3 200 | 1 247 | 105 |
| Tamil Nadu | 263 | 150 | 6 | 0 |
| Total, southern region | 42 633 | 15 477 | 4 756 | 795 |
| Other states and union territories of India | 42 269 | 19 702 | 14 525 | 11 978 |
| Grand total | 84 902 | 35 179 | 19 281 | 12 773 |

[a] No cases were recorded during this period in the union territories of Andaman and Nicobar Islands, Lakshadweep and Pondicherry.
[b] Became the state of Karnataka late in 1973.

June, the team began to extend its activities beyond the boundaries of the city. The investigation of a case brought to the hospital from a village 24 kilometres away revealed an outbreak of 44 cases in 5 villages. The outbreak had begun in January, when migrant workers returned from the neighbouring state of Andhra Pradesh. As in the city, smallpox had spread surprisingly slowly, suggesting again that outbreaks might be readily controlled. Between July 1968 and June 1969 only 2 additional outbreaks were found in all of Tamil Nadu: one comprised 6 cases imported from Madhya Pradesh State, and the other involved a single patient who had been infected in Gujarat State (WHO/SE/70.19, A. R. Rao). Transmission in Tamil Nadu had been interrupted less than 6 months after a single surveillance team had begun its work; after May 1968 the state remained smallpox-free except for importations.

The Madras team had little to do and so, in October 1969, with the agreement of the authorities in the neighbouring state of Andhra Pradesh (population, 43 million), Dr Rao investigated outbreaks in coastal villages 160 kilometres north of Madras. In all, he documented more than 200 cases in the poorly vaccinated population of a group of fishing villages (WHO/SE/70.17, A. R. Rao et al.). This, in turn, stimulated surveillance activity on the part of the state authorities of Andhra Pradesh. The number of cases in Andhra Pradesh diminished from 7951 in 1968 to 1893 in 1969 and to 358 in 1970. However, transmission persisted, primarily among the fishermen and their families, who migrated seasonally from this area northwards to Orissa State.

The success of surveillance and containment measures in both Andhra Pradesh and Tamil Nadu was dramatic, but, despite Dr Rao's presentations at subsequent national and international meetings, little notice was taken of the achievement. The state smallpox eradication programme officer who accompanied Dr Rao to the meetings rightly noted that the vaccination campaign in Tamil Nadu had been exceptionally well executed, but he argued that it was for this reason, and not because of the surveillance–containment activities, that transmission had been interrupted there. Authorities in other states dismissed the attainment as not surprising in the generally more prosperous southern states and of no applicability to most of the rest of India.

### *Western India, 1967–1970*

Although progress in southern India gave cause for optimism, the number of reported cases of smallpox doubled in the western state of Gujarat (population, 27 million), increasing from 3403 cases in 1967 to 7654 in 1968. The epidemic continued into 1969, when 6284 cases were recorded—i.e., one-third of all cases reported in India (Table 15.11) and, in fact, almost one-fifth of all cases reported throughout the world.

WHO proposed to the government of India that a team should visit Gujarat to assess the situation. The government agreed, albeit reluctantly, to a 1-week field trip. Since the 1967 India–WHO assessment of the programme, field visits by WHO Regional Office staff, although resident in New Delhi, had been discouraged. It was the government's view that WHO staff could

Table 15.11. Western India: number of reported cases of smallpox, 1967–1970

| State or union territory | 1967 | 1968 | 1969 | 1970 |
|---|---|---|---|---|
| Chandigarh | 12 | 0 | 0 | 9 |
| Delhi | 472 | 70 | 28 | 96 |
| Gujarat | 3 403 | 7 654 | 6 284 | 2 492 |
| Haryana | 4 809 | 633 | 683 | 2 161 |
| Himachal Pradesh | 44 | 2 | 0 | 1 |
| Jammu and Kashmir | 40 | 1 | 7 | 0 |
| Punjab | 1 393 | 76 | 228 | 234 |
| Rajasthan | 4 506 | 1 923 | 1 439 | 4 097 |
| Total, western region | 14 679 | 10 359 | 8 669 | 9 090 |
| Other states and union territories of India | 70 223 | 24 820 | 10 612 | 3 683 |
| Grand total | 84 902 | 35 179 | 19 281 | 12 773 |

contribute little to a programme that was directed by a national staff who had been engaged in eradication since 1962. Field visits by national staff were likewise uncommon, Dr Singh rarely being able to leave New Delhi because of his innumerable responsibilities. Moreover, his authority was circumscribed because the responsibility for programme execution rested primarily with the states.

In April 1970, a 3-man team, comprising Dr Andrzej Oles, from the WHO Regional Office for South-East Asia, Dr Singh and Henderson, visited Gujarat State and its capital, Ahmedabad (population, 1.7 million). The epidemic in Ahmedabad was considered by local staff to have begun in November 1969 and, to combat it, 150 temporary vaccinators had been hired to supplement a staff consisting of 1 supervisor (medical officer), 39 vaccinators and a 6-man "flying squad". This provided 1 vaccinator for approximately every 9000 persons. The hiring of large numbers of temporary vaccinators without additional supervisors was a common response throughout India to epidemic smallpox. Between January and March 1970, more than 360 000 people had been vaccinated but the number of reported cases continued to increase. The Deputy Director of Health and Medical Services, Dr G. J. Ambwani, had done a commendable job in improving the facilities for vaccine storage and distribution and in introducing the bifurcated needle. Vaccinial immunity was found to be high in all areas which the team visited. The containment of outbreaks was prompt but poorly executed. The team found many additional unreported cases and in none of the outbreaks had an effort been made to identify the source of infection and, thereby, additional outbreaks. Although local civil authorities were responsible for case reporting, almost all the cases were reported by vaccinators.

More disturbing was the discovery that the large numbers of cases reported were not reflected in reports to the national authorities. It was found that the Central Bureau for Health Intelligence had recently informed state statistical sections that it wanted a final report from all districts within 3 weeks of the notification of an outbreak. In Gujarat, this was interpreted to mean that any additional cases that were found after this period or any cases that had experienced the onset of illness more than 3 weeks previously should not be reported to the Central Bureau. The cases were, however, recorded by the state's smallpox eradication programme office. Not only was the epidemic in Gujarat of a far greater magnitude than had been suspected, but the discovery that this new policy had been adopted led to the suspicion that India's remarkable decline in incidence might possibly be an artefact caused by a reporting system distorted by misguided or misunderstood directives.

The team concluded that cases were occurring predominantly among a small, unvaccinated segment of the population, amounting to not more than 5–10% of the total, primarily in slum areas and among migrant labourers.

After just 5 days' work in the field, Dr Ambwani realized that he had not previously understood the surveillance–containment strategy and promised to implement such a programme forthwith. Working with the state smallpox eradication programme officer, Dr S. D. Verma, he was remarkably successful. The numbers of cases declined rapidly and in June 1971, only 14 months after the team's visit, transmission ceased.

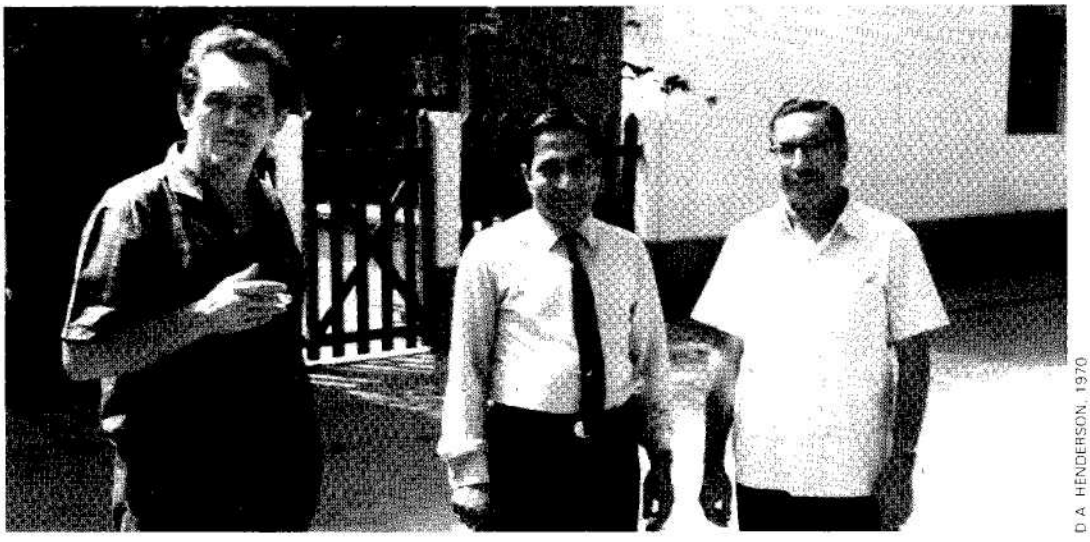


**Plate 15.3.** Members of an Indian/WHO team to assess the smallpox epidemic in Gujarat State in April 1970. *Left to right*: Andrzej J. Oles (b. 1923), an epidemiologist with the WHO Regional Office for South-East Asia; Mahendra K. Singh; and G. J. Ambwani, Deputy Director of Health and Medical Services of Gujarat State.

Other cases occurred later but they were traced to importations from other states. The success in Gujarat suggested to both senior Indian and WHO staff that if states were given modest assistance to foster surveillance–containment programmes, these results might be replicated elsewhere. Unfortunately, Gujarat, like Tamil Nadu, was to prove an exception.

The team returned to New Delhi encouraged by Dr Ambwani's interest in and responsiveness to the surveillance–containment strategy but now less confident that the remarkable decline in the number of reported cases was real. A recommendation was made that the reporting system should be changed but this was vigorously resisted by the director of the Central Bureau for Health Intelligence. Thus, the programme continued, its personnel less certain of the true incidence of smallpox but now placing increased reliance on data provided by state eradication programme officers rather than on official government statistical reports. However, because the quality of the programme officers varied greatly from state to state and because the Central Bureau's directives were variously interpreted by officials at different levels, it was difficult to known what the different sets of numbers really meant without field visits to every state—and no staff were available to undertake such visits.

Yet another disturbing observation was made in the western states in the spring of 1970. It began to appear that smallpox might be moving as an epidemic wave in a clockwise direction around India. In 1967, immediately before the 1968–1969 Gujarat epidemic, Maharashtra, the state immediately to the south, had reported especially severe epidemics. That year, it had recorded 27 961 cases, one-third of all cases reported from India. The number dropped to 3173 in 1968 and to 1411 in 1969. In the spring of 1970, the states of Rajasthan and Haryana, immediately to the north of Gujarat, began to experience major epidemics.

This had not been expected. Since the 19th century, major epidemics in the Indian subcontinent had been observed to occur every 4–7 years, but the periodic fluctuations had been thought to take place more or less simultaneously throughout the country. The wider availability of vaccine had not altered this pattern. That the periodicity had persisted until 1962 was understandable because intensive and widespread vaccination had been conducted during and immediately after epidemics, but as smallpox waned so did interest in vaccination. However, it was quite unexpected that the intensive ongoing national vaccination campaign begun in 1962 had not prevented the 1967 epidemic. To explain this recurrence, it was suggested that many states had not conducted effective

campaigns, and because much of the vaccine used had lacked potency, the large pool of susceptible persons had not significantly diminished. Between 1967 and 1970, however, most of the vaccine reaching recipients was believed to be fully potent and because the number of primary vaccinations had substantially increased, the opinion was held that India should not again experience a major epidemic year. Thus, the recurrence of epidemic smallpox, apparently moving in a clockwise direction around India, was totally unexpected but a critical factor in the formulation of subsequent strategy.

In 1970, senior national government staff began to take a greater interest in the smallpox eradication programme. Epidemic areas in Haryana and Rajasthan abutted on New Delhi, the national capital. Reports of the outbreaks appeared in increasing numbers in New Delhi newspapers, and members of Parliament expressed concern through "call-attention" motions, obliging the government to give an account of what was being done.

The Gujarat team had concluded in its recommendations to the government: "... of greatest importance ... is the need to augment the staff at state level to provide leadership to the programme and to develop and coordinate, by active field work, the very critical surveillance–containment activities." WHO proposed to the government that 4 WHO epidemiologists should be recruited to work as advisers with state programme officers. One would be assigned to Rajasthan, in which smallpox incidence was rapidly rising; one each would be allocated to Uttar Pradesh and Bihar, the two densely populated states comprising most of the northern Ganges river plain, and, if assumptions regarding the clockwise movement of epidemic smallpox were correct, the next to experience major epidemics; the fourth epidemiologist would be assigned to work with state programme officers throughout the southern states in an effort to interrupt transmission in this vast area. Dr Singh, meanwhile, would plan to work with programme officers in the small neighbouring states of Haryana, Punjab and Himachal Pradesh as well as the Delhi Municipal Corporation.

The Director-General of Health Services and the Secretary of Health were initially of the opinion that 2 advisers would suffice but ultimately agreed to 4. On 9 September 1970, an agreement was signed by the government and WHO which committed WHO to provide: (1) 4 epidemiologists and 3 short-term consultants for 3 months each in 1970 and 1971, plus the costs of their travel; (2) vehicles and other supplies; and (3) funds to pay salaries, travel and per diem "for additional personnel employed full-time in smallpox units at the national and state levels up to the limit of Rs. 1 125 000 each year" (US$146 250). In 1970, WHO support to the programme for the first time exceeded US$100 000. During the succeeding 7 years, more than US$11 million would eventually be provided, most of which represented contributions from the government of Sweden (Table 15.12). Additional funds were allocated to the WHO Regional Office for South-East Asia, which as the Indonesian programme concluded, began to devote more time to the programme in India.

## The Foundations are Laid for the Intensified National Campaign, 1971–1973

From 1971 until the summer of 1973 the programme gradually evolved and, in doing

Table 15.12. India: estimated expenditure[a] for smallpox eradication, 1965–1977, by source (thousands of US$)[b]

| Year | India | | WHO | Other[c] | Total |
|---|---|---|---|---|---|
| | Central government | State government | | | |
| 1965 | 2 000 | 6 000 | 21 | 0 | 8 021 |
| 1966 | 2 000 | 6 000 | 19 | 0 | 8 019 |
| 1967 | 2 000 | 6 000 | 36 | 405 | 8 441 |
| 1968 | 2 000 | 6 000 | 45 | 0 | 8 045 |
| 1969 | 2 000 | 6 000 | 5 | 0 | 8 005 |
| 1970 | 2 179 | 6 000 | 182 | 0 | 8 361 |
| 1971 | 2 673 | 6 000 | 267 | 0 | 8 940 |
| 1972 | 4 128 | 6 000 | 352 | 0 | 10 480 |
| 1973 | 3 801 | 5 921 | 505 | 0 | 10 227 |
| 1974 | 4 516 | 5 625 | 2 522 | 483 | 13 146 |
| 1975 | 4 954 | 5 488 | 4 466 | 594 | 15 502 |
| 1976 | 4 556 | 5 000 | 2 642 | 0 | 12 198 |
| 1977 | 5 000 | 5 000 | 1 005 | – | 11 005 |
| Total | 41 807 | 75 034 | 12 067 | 1 482 | 130 390 |

[a] Expenditures by the central government (1965–1969) and state governments (1965–1972) are estimates. Of funds expended by WHO between 1974 and 1977, US$8.1 million were provided by the Swedish International Development Authority.

[b] Excludes the estimated value of vaccine provided between 1965 and 1974, which amounted to 701 million doses from the USSR and 5 million doses from WHO.

[c] Value of contributions in cash and in kind from Tata Industries (US$600 000), USA (US$402 000), UNICEF (US$380 000), and OXFAM (US$100 000).

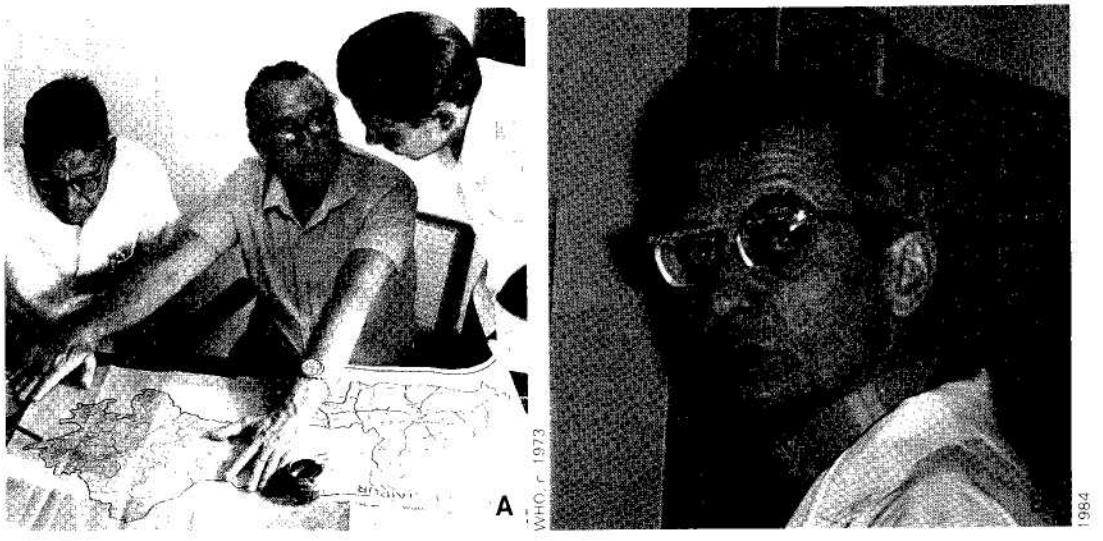


**Plate 15.4.** **A**: Alberto M. Monnier (1914–1979), an epidemiologist, served as the WHO smallpox officer in Rajasthan State from 1971 to 1976. **B**: Viatcheslav A. Moukhopad fulfilled the same role in Uttar Pradesh State from 1971 to 1976.

so, laid the foundations for the intensified national campaign, termed "Smallpox Zero", which began in the autumn of 1973. A closer working relationship was established between the government of India and WHO; the bifurcated needle replaced the rotary lancet in all but a few municipal corporations; the use of liquid vaccine ceased completely; larger quantities of good-quality freeze-dried vaccine produced in India became available; the reporting system was changed; and a procedure for the detection of cases was elaborated.

WHO recruited 2 new regional smallpox advisers, for what was then called the Regional Epidemiological SurveillanceTeam, as well as 4 epidemiologists for assignment to India. Dr Nicole Grasset, a French virologist and epidemiologist, became the regional adviser in 1971, replacing Dr Keja, who had been transferred to Indonesia. She had worked previously in smallpox and measles control activities in eastern Nigeria and had proved to be a charismatic leader. She was joined in the regional office in 1972 by Jeżek as the second regional adviser. Although they were responsible for smallpox eradication activities throughout the South-East Asia Region, much of their work was to be devoted to the programmes in India and Nepal. The 4 epidemiologists for the programme in India were assigned to the states. Dr Alberto Monnier, a Mexican epidemiologist who had been with the Indonesian smallpox eradication programme, began work in Rajasthan in January 1971 and Dr V. A. Moukhopad, a Soviet epidemiologist, arrived a month later to begin work in Uttar Pradesh. That summer, a Czech epidemiologist, Dr Vladimír Zikmund, began work in the southern states. Another epidemiologist reported for duty in Bihar during the summer but stayed only 6 months before resigning. At that time, the post in Bihar was felt to be the least critical, since the available data for 1971 showed smallpox was then concentrated in the north-western part of the country (Fig. 15.6), geographically distant from Bihar. A principal problem in Bihar, as well as in the other states, was the stipulation that each state should provide a vehicle for each adviser and cover the costs of its operation. Rarely before had WHO staff been assigned to work at state level in India and, with vehicles in the states in short supply and poorly maintained, the provision of transport for the advisers was a problem. In Bihar, none was made available and, in general, state officials showed little interest and offered the minimum of cooperation in helping to solve difficulties of this kind. Not until 2 years later were the inadequacies of the Bihar health structure fully appreciated. Conceivably, more energetic measures in Bihar at that time might have averted the catastrophe that lay ahead.

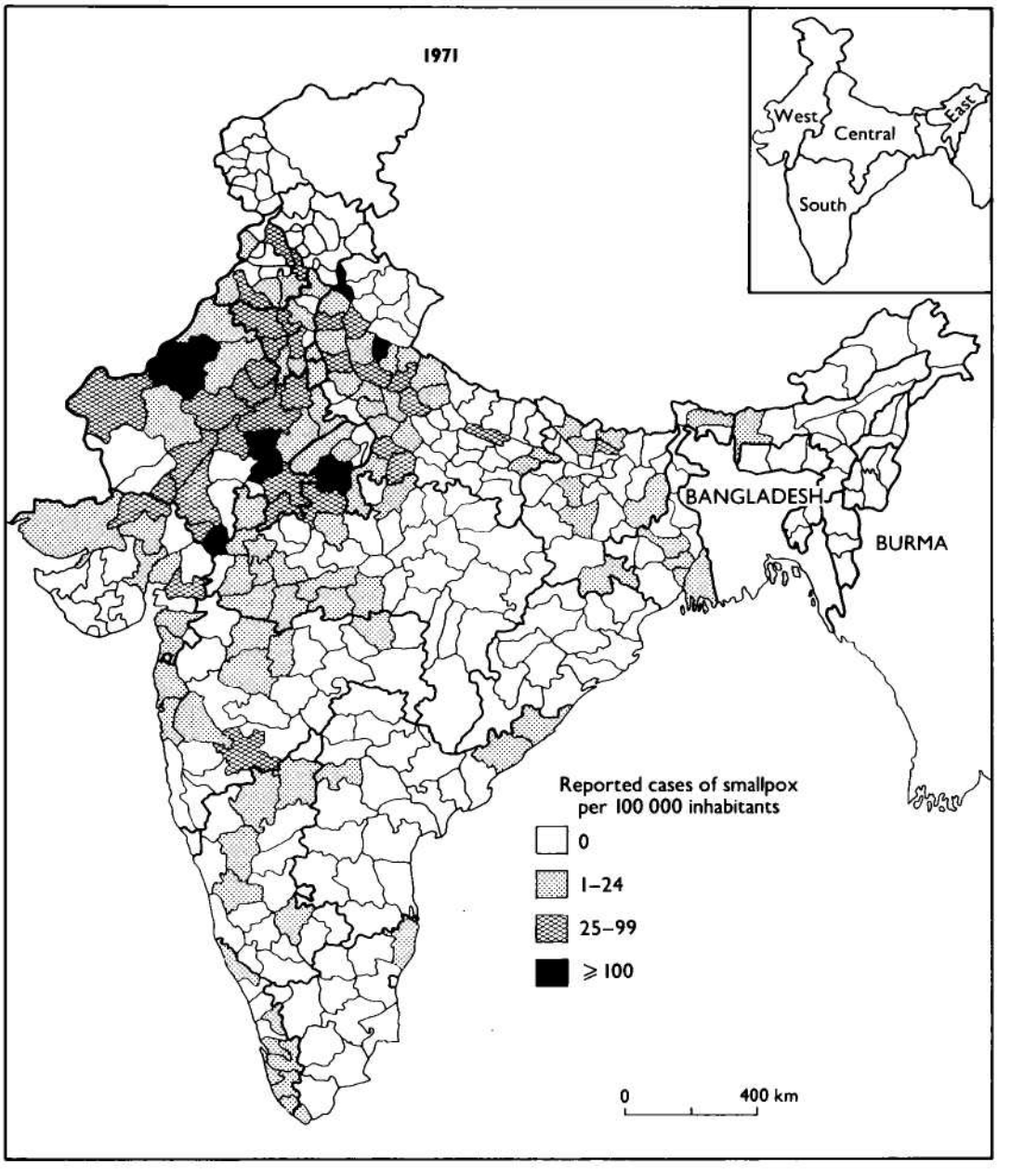


Fig. 15.6. India: number of reported cases of smallpox per 100 000 inhabitants, by district, 1971.

Smallpox eradication activities continued in all states throughout 1971–1973, with varying levels of success. During this period there were developments of particular note in the western states and in Uttar Pradesh, as well as in certain of the areas of low incidence in the south, and an unanticipated setback originating in a Bangladeshi refugee camp in West Bengal. These are described below.

*Western India, 1971–1973*

It had been hoped that the dramatic success of the surveillance–containment programme in Gujarat might be repeated in the other western states and in Uttar Pradesh, in which epidemics were then beginning. Dr Monnier, assigned to Jaipur, the capital of Rajasthan, and Dr Moukhopad, assigned to Lucknow,

the capital of Uttar Pradesh, provided needed support. Full-time assignments were deemed advisable: in Rajasthan because health and other services were less well developed in this conglomerate of former princely states than in most of India; and in Uttar Pradesh because of its vast population (91 million) and its dismal performance during the mass vaccination campaign.

Rajasthan, besides having a less adequate structure of health services and a less literate population than much of India, was geographically a problem, nearly two-thirds of its area being desert and semi-desert. Roads were few and working conditions demanding. The population of 26.5 million was principally settled in 151 towns and 33 305 villages, but there were nomads as well. Three state teams were created which were directed, respectively, by the Deputy Director for Communicable Diseases, Dr M. L. Aggarwal; his deputy, Dr D. K. Jagdev; and Dr Monnier. Each was assigned a paramedical assistant. Vehicles were made available sporadically for the state officials but Dr Monnier used his private car for almost a year until it was agreed that WHO would provide him with a vehicle. In addition to training district and local staff in reporting and containment measures during their extensive travels and in specially convened meetings, the teams undertook to detect and contain outbreaks.

As in other countries, the discovery of suspected cases was usually accomplished by questioning village leaders, schoolteachers and their pupils, and people attending weekly markets. In Rajasthan and in many other parts of India, there were two additional methods, unique to India, by which cases could be detected. One consisted in questioning visitors to the Sītalā mata temples. Many villagers came to give thanks to the goddess for recovery from smallpox or to offer homage in the hope that they and their families would be spared a visitation by the goddess. Cases could also be detected in villages when, as was customary in many areas, branches from the neem tree were hung over the front door of a house in which a patient lived. The leaves of the neem were considered to have special cooling properties when applied to the skin of the patient and other, less tangible, properties when hung above the doorway.

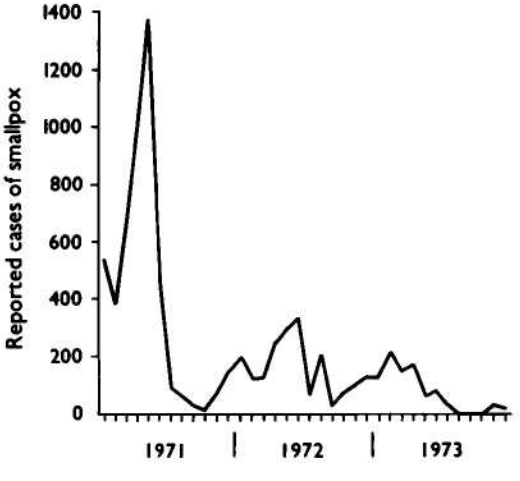


Fig. 15.7. Rajasthan State: number of reported cases of smallpox, by month, 1971–1973.

The programme in Rajasthan made commendable progress. At the beginning of the summer of 1971, the number of reported cases declined steeply, and the incidence remained comparatively low during the spring smallpox season of 1972 (Fig. 15.7). In October, in order to strengthen the programme, other health workers, such as the family planning and malaria eradication programme staff, were directed to report any smallpox cases found during the course of their work. A further decline in incidence occurred in 1973 (Table 15.13), and from August to October 1973 no cases whatsoever were detected. Cases occurred subsequently in Rajasthan, but they originated from importations. The results were impressive and what had been hoped for, although the programme was undoubtedly assisted, as in Gujarat, by a decline in incidence associated with the longer-term fluctuations of smallpox. Nevertheless, little more than 2 years had elapsed between the time the surveillance teams

Table 15.13. Western India: number of reported cases of smallpox, 1971–1973

| State or union territory | 1971 | 1972 | 1973 |
|---|---|---|---|
| Chandigarh | 0 | 0 | 0 |
| Delhi | 318 | 149 | 168 |
| Gujarat | 238 | 39 | 9 |
| Haryana | 2 635 | 1 532 | 188 |
| Himachal Pradesh | 11 | 0 | 2 |
| Jammu and Kashmir | 11 | 272 | 941 |
| Punjab | 101 | 139 | 65 |
| Rajasthan | 4 827 | 1 970 | 877 |
| Total, western region | 8 141 | 4 101 | 2 250 |
| Other states and union territories of India | 8 049 | 23 306 | 85 864 |
| Grand total | 16 190 | 27 407 | 88 114 |

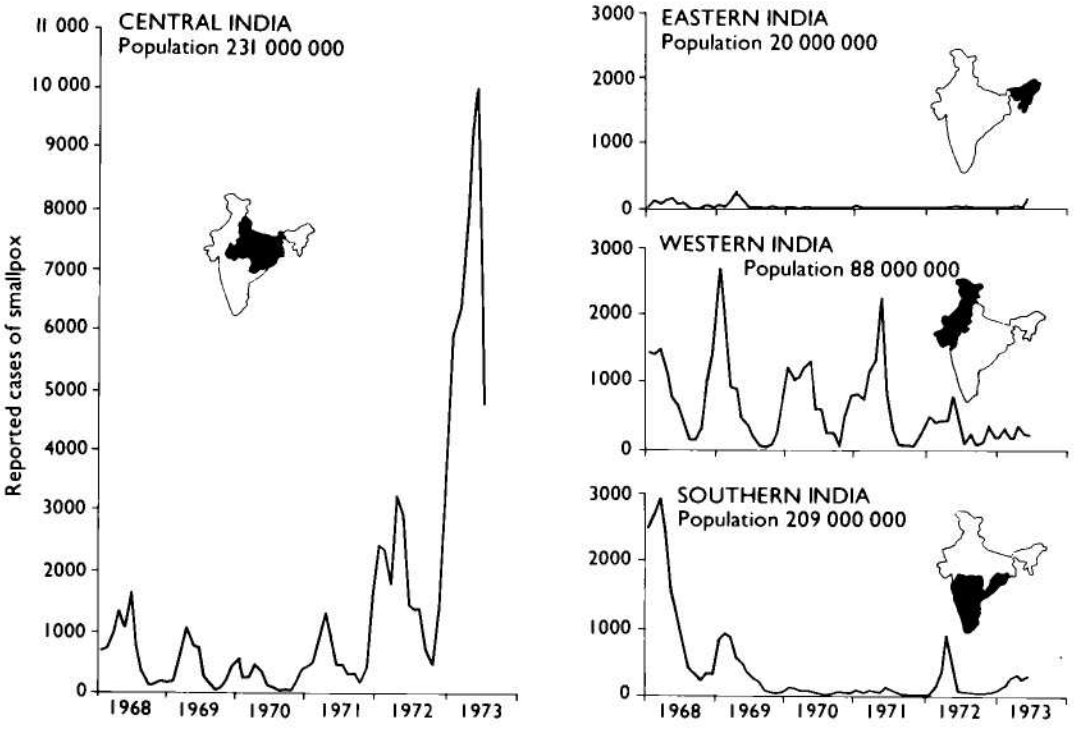


Fig. 15.8. India: number of reported cases of smallpox, by region, by month, 1968–1973. (Population data for 1971 from Basu et al., 1979.)

had begun work and the unprecedented occurrence of 3 months without detectable smallpox.

Dr Singh, through such visits as he could make to the western states near New Delhi, was no less successful in stimulating effective surveillance–containment programmes. The number of cases in the contiguous states of Haryana, Himachal Pradesh and Punjab and in Delhi Municipal Corporation (total population, 32 million) fell somewhat less steeply than in Rajasthan, but by the winter of 1972–1973 fewer than 100 cases were being detected monthly, many of which resulted from importations from the neighbouring state of Uttar Pradesh. By September 1973, transmission had been interrupted throughout this entire area, the only reported cases resulting from importations into New Delhi.

Meanwhile, the programme in Gujarat had progressed so satisfactorily that only 44 outbreaks were detected during the first 6 months of 1971, and none whatsoever from July to the end of October. It seemed impossible that transmission could have been stopped in a state so heavily infected as recently as 1970. Accordingly, Arita was asked to direct a special assessment of the state in November 1971. During a 3-week period, he led a 6-member team which visited 90 towns and villages in high-risk areas of 11 districts. No evidence of smallpox since June of that year could be found. The success reflected, in part, improved case detection and containment of outbreaks, but intensive vaccination undoubtedly also played a role. District surveys in September 1971 revealed that vaccination scars were present in 98–99% of those aged 5–14 years, in 96–99% of those aged 1–4 years and in 66–88% of those aged less than 1 year.

The smallpox eradication programme throughout the western states was progressing everywhere as had been hoped (Fig. 15.8) with a single exception—the northern state of Jammu and Kashmir (population, 4.8 million), which had once been free of smallpox. In the autumn of 1972, the state began reporting increasing numbers of cases. Until October, Jammu and Kashmir had experienced only occasional importations which, according to state reports, had been quickly contained. It had been hoped that by preventing smallpox from becoming re-established in Himachal Pradesh, a geo-

graphical barrier to the northward spread of the epidemic would be created, preventing the disease from reaching Jammu and Kashmir. Dr Singh, working with effective state programme staff, proved successful in maintaining the non-endemic status of Himachal Pradesh. Unfortunately, many travellers to Jammu and Kashmir imported smallpox from infected areas more than 50 kilometres away. Because of the paucity of senior smallpox advisers, assistance had not been provided to state staff in Jammu and Kashmir and the health services had been unable to cope. The failure to strengthen activities in this state was an omission for which the programme would subsequently pay dearly in additional effort.

*Uttar Pradesh, 1971–1973*

The development of surveillance–containment programmes in the western states proved to be comparatively straightforward, but in the adjacent state of Uttar Pradesh, the experience was entirely different. Uttar Pradesh was India's most populous state (population, 91 million) with a density of 300 persons per square kilometre. Most of the state comprises the Ganges river plain, where population densities were among the highest in India and where transport and communication services were quite well developed. There was an extensive, well-established infrastructure of health services and a large, reasonably well trained health staff. In retrospect, unexpected problems might perhaps have been foreseen because of Uttar Pradesh's poor performance in the mass vaccination campaign, and because it was the last state in India to replace the rotary lancet with the bifurcated needle (1971).

During 1971, Dr Moukhopad and the state programme officer travelled extensively to conduct regional training programmes for all district health officers and their programme staff. However, almost as soon as they were trained in reporting and in surveillance–containment procedures, they were transferred to other districts or assumed other duties. Many who reported substantial numbers of cases of smallpox from their districts were disciplined by the state Director of Health Services by being transferred to hardship posts on the grounds that the presence of cases was tacit evidence that they had not conducted an effective vaccination campaign. Although other states followed this practice, none did so as frequently as Uttar Pradesh and neighbouring states in northern India. Continuing efforts were made by national staff and WHO advisers to persuade state officials that their actions were counter-productive, but with only partial success.

Progress in the programme in Uttar Pradesh was difficult to assess, in part because of the suppression of reports by district officers and in part because of the archaic state and national reporting system. During 1971, the number of cases reported from Uttar Pradesh to the Central Bureau for Health Intelligence never reached 500 per month, and indeed between July and September of that year fewer than 100 cases were notified each month for the entire state. The relevant data, reported to the Central Bureau and to WHO up to 26 October 1971, are shown in Table 15.14 (*Wkly epidem. Rec.*, 1971b). Even if one were to assume that there were 10 times as many cases as had been reported, not only Uttar Pradesh but India as a whole appeared to have very few chains of smallpox infection. On the basis of a growing experience with surveillance–containment programmes, it seemed reasonable to expect that transmission could be interrupted comparatively easily and rapidly. The greatest impediment in assessing the true situation and in deciding how best to deploy resources to achieve this goal was the reporting system.

In November 1971, the government and a new acting director of the Central Bureau for Health Intelligence agreed to modernize the reporting system so that its procedures would resemble those used in other countries. Each primary health centre was directed to notify to the district on Saturday of each week the total number of cases detected that week irrespective of the date of onset. If no cases were reported, a "nil" report was to be submitted. The submission of a nil report was a most important feature. Previously, the absence of a report had been assumed to mean an absence of cases when, in fact, the responsible medical officer may have been negligent in reporting or had decided not to report because there were a great many cases. Officials who had been accustomed to suppressing information through the simple expedient of not submitting a report found it difficult to indulge in deliberate falsification. The districts were asked to ensure that reports from all primary health centres were

Table 15.14. India: number of reported cases of smallpox, by state and union territory and by month, 1971[a]

| State or union territory | Population[b] (millions) | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **South**[c] | | | | | | | | | | | |
| Andhra Pradesh | 44.8 | 50 | 28 | 58 | 29 | 14 | 12 | 0 | 0 | 0 | 191 |
| Goa, Daman and Diu | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kerala | 22.0 | 63 | 39 | 10 | 2 | 0 | 0 | 0 | 0 | 0 | 114 |
| Maharashtra | 51.9 | 1 | 3 | 15 | 8 | 3 | 16 | 24 | 16 | 25 | 111 |
| Mysore[d] | 30.2 | 13 | 37 | 34 | 5 | 0 | 36 | 10 | 9 | 1 | 145 |
| Orissa | 22.6 | 1 | 1 | 3 | 0 | 4 | 2 | 2 | 0 | 0 | 13 |
| Tamil Nadu | 42.4 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| **East**[c] | | | | | | | | | | | |
| Assam | 15.1 | 35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35 |
| Manipur | 1.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .. | .. | 0 |
| Nagaland | 0.5 | 0 | 0 | .. | .. | .. | .. | .. | .. | .. | 0 |
| North East Frontier Agency[e] | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .. | .. | 0 |
| Tripura | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **West** | | | | | | | | | | | |
| Chandigarh | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Delhi | 4.2 | 2 | 7 | 70 | 86 | 89 | 34 | 12 | 8 | 3 | 311 |
| Gujarat | 27.5 | 18 | 79 | 53 | 27 | 20 | 0 | 0 | 0 | 0 | 197 |
| Haryana | 10.3 | 139 | 280 | 426 | 270 | 651 | 336 | 141 | 19 | 13 | 2 282 |
| Himachal Pradesh | 3.6 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | .. | 3 |
| Jammu and Kashmir | 4.8 | 0 | 0 | 0 | 2 | 7 | 0 | 0 | .. | .. | 9 |
| Punjab | 13.9 | 27 | 19 | 4 | 3 | 10 | 1 | 0 | 0 | 0 | 64 |
| Rajasthan | 26.5 | 545 | 383 | 917 | 943 | 786 | 482 | 65 | 44 | 8 | 4 173 |
| **Central** | | | | | | | | | | | |
| Bihar | 58.0 | 28 | 33 | 336 | 179 | 109 | 77 | 97 | .. | 63 | 922 |
| Madhya Pradesh | 42.9 | 72 | 63 | 37 | 112 | 21 | 53 | 43 | 21 | 2 | 424 |
| Uttar Pradesh | 90.9 | 275 | 347 | 417 | 405 | 319 | 135 | 69 | 27 | 20 | 2 014 |
| West Bengal | 45.6 | 4 | 40 | 102 | 49 | 38 | 18 | 5 | 1 | 1 | 258 |
| Total | | 1 273 | 1 359 | 2 487 | 2 120 | 2 072 | 1 202 | 470 | 145 | 143 | 11 271 |

[a] Data reported to WHO up to 26 October 1971 (*Wkly epid. Rec.*, 1971b). .. = data not recorded.

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

[c] No cases were reported during this period in the union territories of Andaman and Nicobar Islands, Dadra and Nagar Haveli, Lakshadweep, Pondicherry, and Mizoram, and the state of Meghalaya.

[d] Became the state of Karnataka late in 1973.

[e] Became the union territory of Arunachal Pradesh in 1972.

submitted and to compile all reports then available on the following Tuesday and to send them to the state smallpox eradication programme office. The state, in turn, was made responsible for ensuring that all districts reported and, on each Thursday, for telegraphing a report to the Central Bureau for Health Intelligence and the National Smallpox Eradication Programme office. Many months, and in some states several years, of work were required before the reporting system functioned well but a major obstacle to the achievement of eradication in India had at last been removed.

In November 1971, Uttar Pradesh was the first state to implement the new reporting scheme. By February 1972, the number of districts which had not reported for 3 weeks or more had fallen from 17 to only 5, and by summer, 48 of the 55 districts were submitting reports promptly each week. Whether because of improved reporting or because of an actual increase in incidence, the number of recorded cases rose during the winter of 1971–1972 to between 1200 and 1600 each month (Fig. 15.9)—but still, in a population of 91 million, this was not a great number. Senior staff continued to believe that with sustained support to the surveillance–containment effort, Uttar Pradesh would repeat the experience of the western states. It was not to be. Smallpox eradication staff were diverted to perform cholera vaccinations between September and December 1972, at a time when the containment of smallpox outbreaks was most crucial. Although cholera vaccine had been shown to be of little value, this was the usual and politically acceptable response of the health services when cholera occurred. Explosive outbreaks of smallpox spread across the state; the number of cases increased rapidly during the early months of 1973, reaching a peak in May, when 5000 cases were reported.

Particularly discouraging was the continuing antipathy of state officials to the surveillance–containment strategy. An episode in early April 1973 in the district of Muzaffarnagar vividly illustrated the prevailing attitude. This district, located less than 100 kilometres north of New Delhi, began experiencing outbreaks of smallpox in the autumn of 1972 and, in January, reported 440 cases. This greatly exceeded the number reported that month by any other district of India except 2 districts in West Bengal associated with the Salt Lake Refugee Camp disaster (see later in this chapter). In February 1973, Arita joined Dr Moukhopad in a special investigation of the problem. Active searches at schools and markets soon revealed that although the reported smallpox incidence was high, there were many other undetected and uncontrolled outbreaks occurring throughout the district. With the cooperation of a responsible, energetic district health officer, they decided to mobilize all health staff throughout the district by closing the health centres and training the staff to undertake a 2-week systematic village-by-village search for cases. The health staff responded with enthusiasm and efficiency and soon discovered that cases were occurring in more than half the villages. In all, 641 cases were discovered in February and 1219 in March. Containment measures had scarcely begun, however, when the state Director of Health Services ordered the cessation of all surveillance–containment operations and the immediate vaccination of the entire population of the district. He then warned that when this had been completed the report of any further cases would result in the transfer of the district health officer to the most unpleasant post in the state. It was clear that considerable persuasion of state officials and heroic efforts in the field would be required if Uttar Pradesh was to become free of smallpox. However, the demonstration that it was possible to mobilize effectively the poorly supervised army of health staff offered hope for the future.

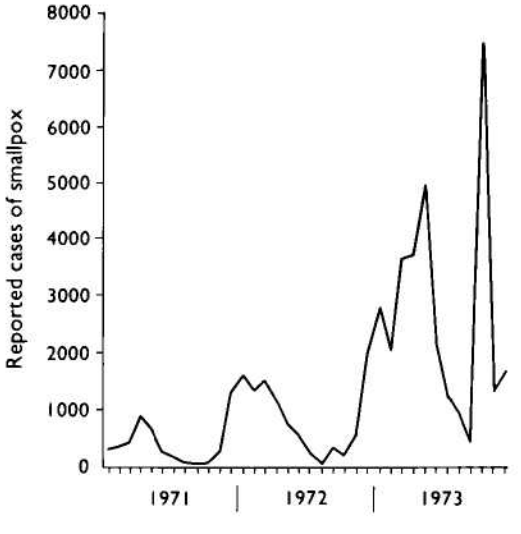


Fig. 15.9. Uttar Pradesh State: number of reported cases of smallpox, by month, 1971–1973.

*The southern states, 1971–1973*

In the southern states, it had been hoped that the WHO adviser, Dr Zikmund, working with state programme officers might succeed reasonably quickly in developing surveillance–containment activities to the point of interrupting transmission throughout the entire area. Tamil Nadu continued its successful programme and from the beginning of 1971 to the end of 1973 only 11 cases were recorded (Table 15.15), all following well-documented importations. Mysore (renamed Karnataka in 1973) and Andhra Pradesh, the contiguous states to the north, were targets of high priority. Virtually all cases in Andhra Pradesh occurred during the first half of 1971 among generally uncooperative, poorly vaccinated fishermen who migrated seasonally between Andhra Pradesh and Orissa. District health officials, considering them to be temporary residents, had ignored them. Once vaccination and outbreak containment began, transmission quickly stopped. In Mysore, 185 of the 223 cases reported during 1971 were from a single district and these outbreaks were contained by midsummer. Maharashtra was also successful in stopping transmission. In the entire southern area, between October 1971 and January 1972, only 45 cases were detected, all of them occurring in 3 districts. Considering that the southern states accounted for 38% of India's total population, there was reason for optimism about the prospects for the eradication of smallpox in India.

Uncertainty persisted, however, about the situation in the state of Kerala. There, smallpox transmission appeared to have been interrupted in 1967, only 42 cases, presumably importations, having been detected between 1968 and 1970. However, between January and May 1971, 105 cases were

reported, with 1 additional case in September and 2 in November. Kerala's health services, among the best in India, reported that the cases had not occurred in outbreaks as one would expect, but rather were scattered across 7 of its 10 districts. Because the epidemiological pattern of the cases was difficult to explain, Arita joined state officials in a special study in February 1972. Of the reported cases, 70% were found to be in persons over 15 years of age, and of the patients whose vaccination status was known, 102 had previously been vaccinated. Arita and his collaborators examined 35 patients who had recovered, but none had the residual pockmarks typical of smallpox. As it turned out, the state in late 1970 had requested health staff to begin to collect specimens from patients with chickenpox as well as from those with suspected smallpox to confirm with greater certainty that the state was smallpox-free. A state laboratory with little experience in the identification of variola virus had examined the specimens using the gel-precipitation technique and reported that 104 out of 386 tested were either "positive" or "doubtful" for variola virus. Although there was little doubt on the part of physicians about the clinical diagnosis, the virological reports were accepted and the cases duly notified. The team eventually concluded that none of the reported cases was smallpox and the reports were retracted. Except for 4 imported cases in 1974, Kerala was to remain smallpox-free.

The findings in Kerala provided further encouragement but, in February 1972, it suddenly became apparent that there were serious, hitherto unrecognized, problems in Mysore. The discovery of smallpox in Mysore was made by surveillance teams in the neighbouring state of Andhra Pradesh, whose programme was directed by Dr M. C. Appa Rao. There, case detection had improved significantly when, at the end of 1971, a sum of 10 rupees (US$1.33) was awarded by the government for the discovery of a case—the first time in India that such a reward had been offered. The teams detected outbreaks in Hyderabad whose source of infection was a village in Gulbarga District, one of 19 districts of Mysore State. The outbreak was unknown to the Mysore state programme officer. The district (population, 1.7 million) had an extensive network of health facilities, including a large general hospital, 71 health centres and dispensaries, a medical college, and special programmes for the control of malaria, filariasis and tuberculosis and for family planning. It was assumed that if smallpox cases had been present, they would have been quickly detected. State officials, in collaboration with Dr Zikmund, began an immediate investigation. It soon became apparent that not one but numerous outbreaks had occurred, beginning almost 15 months earlier, in December 1970. By the end of March, the investigators had discovered 81 outbreaks and 730 cases. They found that even the staff members of primary health centres who lived in villages with major outbreaks had not reported them; many directors of primary health centres who were notified of cases dismissed them as chickenpox; and, indeed, the District Director of Health and Family Planning, who had been officially informed of smallpox cases as early as September 1971, had suppressed the reports. It was concluded that radical measures would be required to stop the epidemic.

Able leadership was provided by a newly appointed District Medical Officer of Health, Dr Rama Rao; health staff were transferred from other districts; and all health and family planning staff in Gulbarga District were mobilized to undertake repeated house-to-house searches for cases throughout the district. When outbreaks were discovered, they were promptly contained. New outbreaks rapidly decreased in number, from 34 in April to 12 in May and 4 in June. To counter the tendency to conceal cases, a reward of 25 rupees (US$3.33) was offered to anyone who reported a case of smallpox.

Table 15.15. Southern India: number of reported cases of smallpox, 1971–1973[a]

| State or union territory | 1971 | 1972 | 1973 |
|---|---|---|---|
| Andhra Pradesh | 214 | 405 | 1 295 |
| Dadra and Nagar Haveli | 0 | 0 | 1 |
| Kerala | 0 | 0 | 0 |
| Maharashtra | 160 | 215 | 158 |
| Mysore[b] | 223 | 1 299 | 6 |
| Orissa | 16 | 5 | 1 276 |
| Tamil Nadu | 7 | 1 | 3 |
| Total | 620 | 1 925 | 2 739 |
| Other states and union territories of India | 15 570 | 25 482 | 85 375 |
| Grand total | 16 190 | 27 407 | 88 114 |

[a] No cases were reported during this period from the union territories of the Andaman and Nicobar Islands, Goa, Daman and Diu, Lakshadweep, and Pondicherry.

[b] Became the state of Karnataka late in 1973.

### Chickenpox—a Problem in Surveillance in Kerala

Cases of and deaths from severe chickenpox proved the most difficult in differential diagnosis. The most problematic cases were those in adults. Among residents of the southern state of Kerala (population, 24 million), as well as among migrants from that state, cases of chickenpox in adults occurred with unusual frequency, and this resulted in a number of erroneous reports and special investigations. In the process of confirming that transmission had been interrupted in India, a special study was conducted in Kerala to ascertain that the deaths attributed to chickenpox had been correctly diagnosed (White, 1978).

*Age Distribution of Deaths Due to Chickenpox, January 1975–March 1976*

| *Age group (years)* | *Males* | *Females* | *Total* | *Prevalence per 100 000 of cases of chickenpox*[a] |
|---|---|---|---|---|
| 0–4 | 6 | 3 | 9 | 64 |
| 5–9 | 2 | 1 | 3 | 102 |
| 10–19 | 4 | 3 | 7 | 87 |
| 20–29 | 1 | 3 | 4 | 59 |
| 30–39 | 14 | 3 | 17 | 56 |
| 40–49 | 34 | 1 | 35 | 69 |
| 50–59 | 34 | 5 | 39 | 48 |
| 60–69 | 31 | 14 | 45 | 31 |
| ⩾70 | 74 | 27 | 101 | 36 |
| Total | 200 | 60 | 260 | 71 |

[a] Based on a special search in April 1976 in 11 primary health centres.

Of 260 persons who died of chickenpox over a 15-month period, 241 were 20 years of age and older. For many, the immediate cause of death was attributed to "old age" or a chronic or unrelated acute illness, although chickenpox may have been cited as a contributory factor.

It was suggested that the frequency of adult cases related to the dispersed population in Kerala and, until recently, the difficulty of travelling from one village to another. Thus, it was reasoned, many were not exposed to chickenpox until they were adults. The hypothesis was attractive, but other factors must have been involved because adult chickenpox was not such a problem in other, even more isolated, areas of Africa and Asia.

However, cases spread from Gulbarga to 5 other districts in Mysore, to 2 districts in Andhra Pradesh and to at least 1 district in Maharashtra. More than 1400 cases in all were traced to this single district. Although the outbreaks were largely contained in a period of 2 months, fully 6 months elapsed before transmission finally ceased. Most surprising to senior Indian and WHO staff alike were the numbers of health staff who could be mobilized, the rapidity with which a search programme could be organized, and the responsiveness of staff in executing a well-conceived plan. This experience was subsequently replicated in Muzaffarnagar District, Uttar Pradesh (see previous section) and, in May 1973, throughout Orissa State. It ultimately led to the plan to undertake nation-wide searches for smallpox cases—the essential strategic component of the campaign beginning in the autumn of 1973.

Although transmission was successfully interrupted in Mysore by September 1972, Hyderabad, the capital of Andhra Pradesh, had by then been reinfected; from there the disease spread to 8 other districts. Dr Appa Rao, who was responsible for other programmes in addition to smallpox eradication, was unable to devote sufficient time to the programme and smallpox continued to spread, albeit slowly. Smallpox was reasonably well contained, with the help of Dr Zikmund, until January 1973, when he was forced to leave for Orissa because of outbreaks there

resulting from importations from the Salt Lake Refugee Camp. Smallpox continued to spread in Andhra Pradesh. Between January and June 1973, 924 cases occurred. In view of the size of the population (47 million), the number of cases was not large but, clearly, transmission in Andhra Pradesh and the southern states was not being interrupted as quickly or as easily as had been hoped. The potential for epidemic spread remained, as the Gulbarga experience had shown. The movement of smallpox was too rapid and effective to be contained by the few epidemiologists available.

### *West Bengal and the Salt Lake Refugee Camp, 1971*

The densely populated state of West Bengal (population, 46 million), with its crowded capital city of Calcutta (population, 7 million), was a demographic centre of vital importance to smallpox eradication in the eastern states of India. In West Bengal, progress in the control of smallpox appeared to be satisfactory—until December 1971. The number of recorded cases had diminished to only 374 in 1970 and to 217 in 1971, the lowest totals ever reported. The Eastern Province of Pakistan (later Bangladesh) on its eastern border, predominantly Muslim but also Bengali-speaking, had detected its last case in August 1970 (see Chapter 16). Thus, importations of smallpox by travellers who frequently crossed the border were not a threat. However, civil war began in March 1971 in East Pakistan, and during that year an estimated 10 million refugees fled across the border into India. Numerous refugee camps were set up, primarily in West Bengal, Madhya Pradesh and Assam. It was feared that if smallpox were introduced into the camps, devastating epidemics would rapidly develop. On the orders of the National Smallpox Eradication Programme staff, all refugees entering the camps were examined for the presence of smallpox, but no cases were found. As a preventive measure, state officials were requested to ensure that all persons entering the camps were vaccinated. Indian national staff and WHO advisers visited and confirmed that this procedure had been followed in a number of camps, but not in West Bengal, where the state authorities refused to permit national intervention. The largest refugee camp, the Salt Lake Camp near Calcutta, sheltered an estimated 200 000–300 000 persons, and there an international private voluntary organization had been given responsibility for providing health services. For reasons unknown, no vaccination campaign was conducted.

Smallpox was probably introduced into the Salt Lake Camp in November. Many cases were hospitalized within the camp but were diagnosed as chickenpox. The diagnosis of probable smallpox was finally made on 19 January 1972 by an epidemiologist in the USA while viewing a television news documentary made in the camp. The report was relayed rapidly from Atlanta to Geneva to New Delhi. The Director of Health Services of West Bengal categorically denied there were cases, but Dr S. N. Ray, from the National Programme office, flew to Calcutta and, on visiting the camp, found an extensive outbreak. A vaccination programme was begun, but it was too late. On 16 December 1971, one month earlier, the independence of Bangladesh had been proclaimed. By 20 January 1972, an estimated 50 000 refugees had already departed for Bangladesh. The epidemic spread from the camp through West Bengal and from there to the neighbouring states of Orissa and Bihar. West Bengal, which had detected only 217 cases in 1971, reported 4753 in 1972; Bihar reported 1307 cases in 1971 and 4153 in 1972.

The number of cases that occurred in the camp can never be known, but as from 22 January, infected persons among the refugees remaining in the camp were admitted to the Calcutta Infectious Diseases Hospital; admissions continued until the end of February. During this period, the hospital admitted 764 patients, of whom 48% died (Guha Mazumder & Chakraborty, 1973).

West Bengal, which had been comparatively free of smallpox in 1971, became a major epidemic focus in 1972 (Fig. 15.10) and Bangladesh was again reinfected (see Chapter 16).

### *The beginning of the "final phase" of the Intensified Smallpox Eradication Programme, November 1972*

By the autumn of 1972, global progress in the Intensified Programme was most encouraging. Only 3 endemic countries remained in the whole of Africa—Ethiopia, Botswana and the Sudan—and in the latter two interruption of transmission appeared imminent. Both South America and Indonesia were smallpox-

free and Afghanistan was almost so. Bangladesh had been reinfected but it had re-established its national programme and Pakistan's programme had been extended to the entire country. India was reporting increasing numbers of cases as epidemic smallpox began moving across the Ganges plain from the west and from Calcutta in the east. However, the extent of the infected areas in India, as well as in other Asian countries, had diminished significantly (Fig. 15.11).

With endemic smallpox so limited geographically and some form of surveillance operating in all areas, it seemed to WHO propitious to encourage a more concentrated effort in the remaining infected areas: the "final phase" of the Intensified Programme. The proposed target was ambitious—to interrupt smallpox transmission during the following 2 smallpox seasons, a period of about 18 months. To encourage the renewed effort, special seminars were convened in

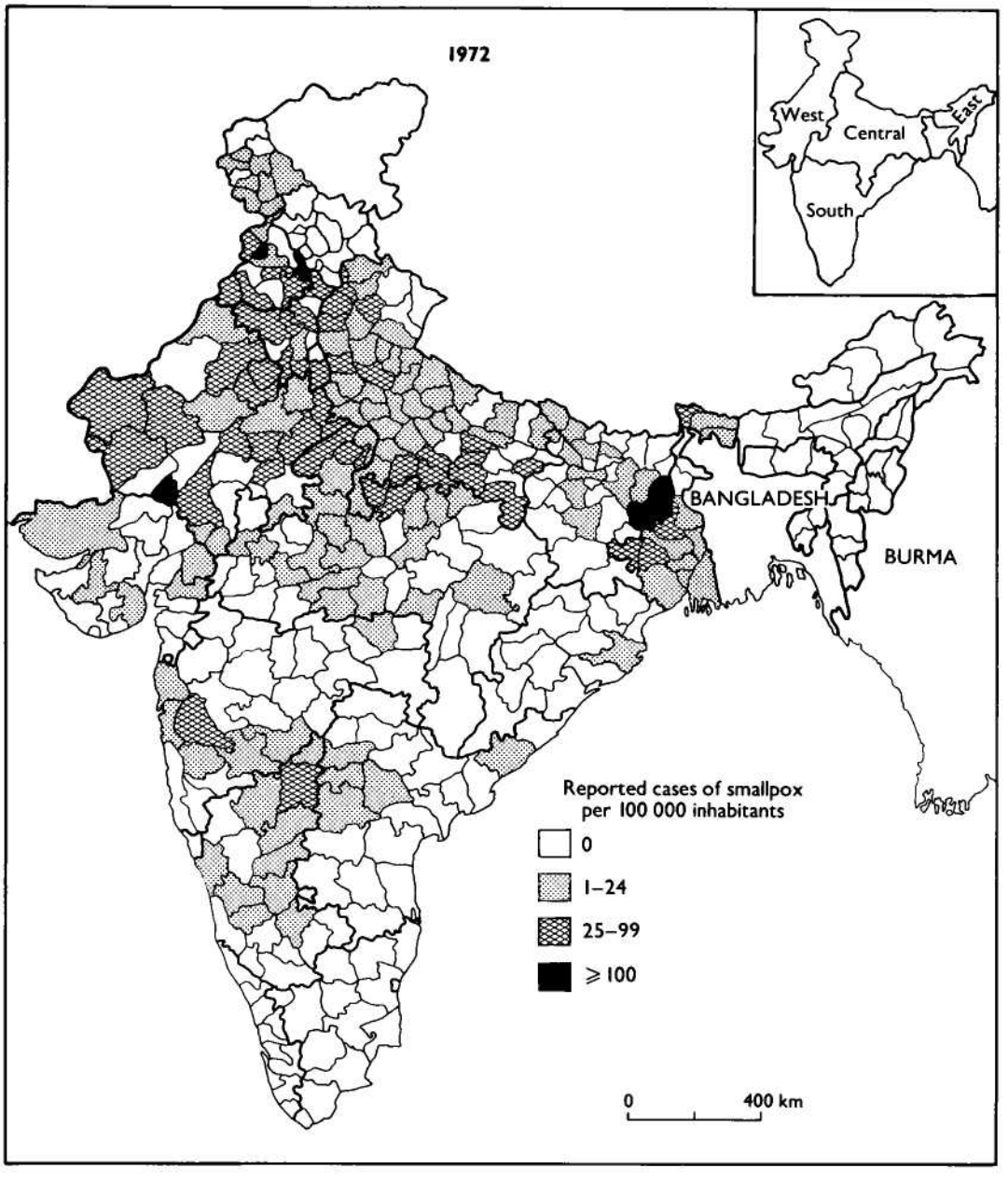


Fig. 15.10. India: number of reported cases of smallpox per 100 000 inhabitants, by district, 1972.

September–November in Addis Abeba (mainly for staff in Ethiopia and the Sudan); in Karachi (principally for staff in Afghanistan and Pakistan); and in New Delhi (for staff in Bangladesh, Bhutan, India and Nepal).

In India, despite the success of surveillance–containment measures in southern and western states, many state health officials still persisted in their belief that 100% vaccination was the only way to achieve eradication. With officials from all over India attending the seminar, attention was focused explicitly on the surveillance–containment strategy. The success in Indonesia was a helpful stimulus in encouraging a change in direction, as is illustrated in the following extract from Henderson's opening address:

"Two years ago, in December 1970, a seminar on smallpox eradication was held in this very room. I said at that time that the question was repeatedly asked as to how such major changes [in the smallpox eradication programme] could occur so rapidly when, for years, many endemic countries had been conducting mass vaccination programmes with only limited success. The principal difference between present and past efforts is one component—surveillance. In every country where a concerted effort has been made to investigate promptly and to contain *every* outbreak, smallpox transmission has been interrupted within two years or less. Many of you will recall that at that Seminar the director of the Indonesian programme presented a provocative paper which stated 'a proper surveillance–containment action brought smallpox under control in a short period,

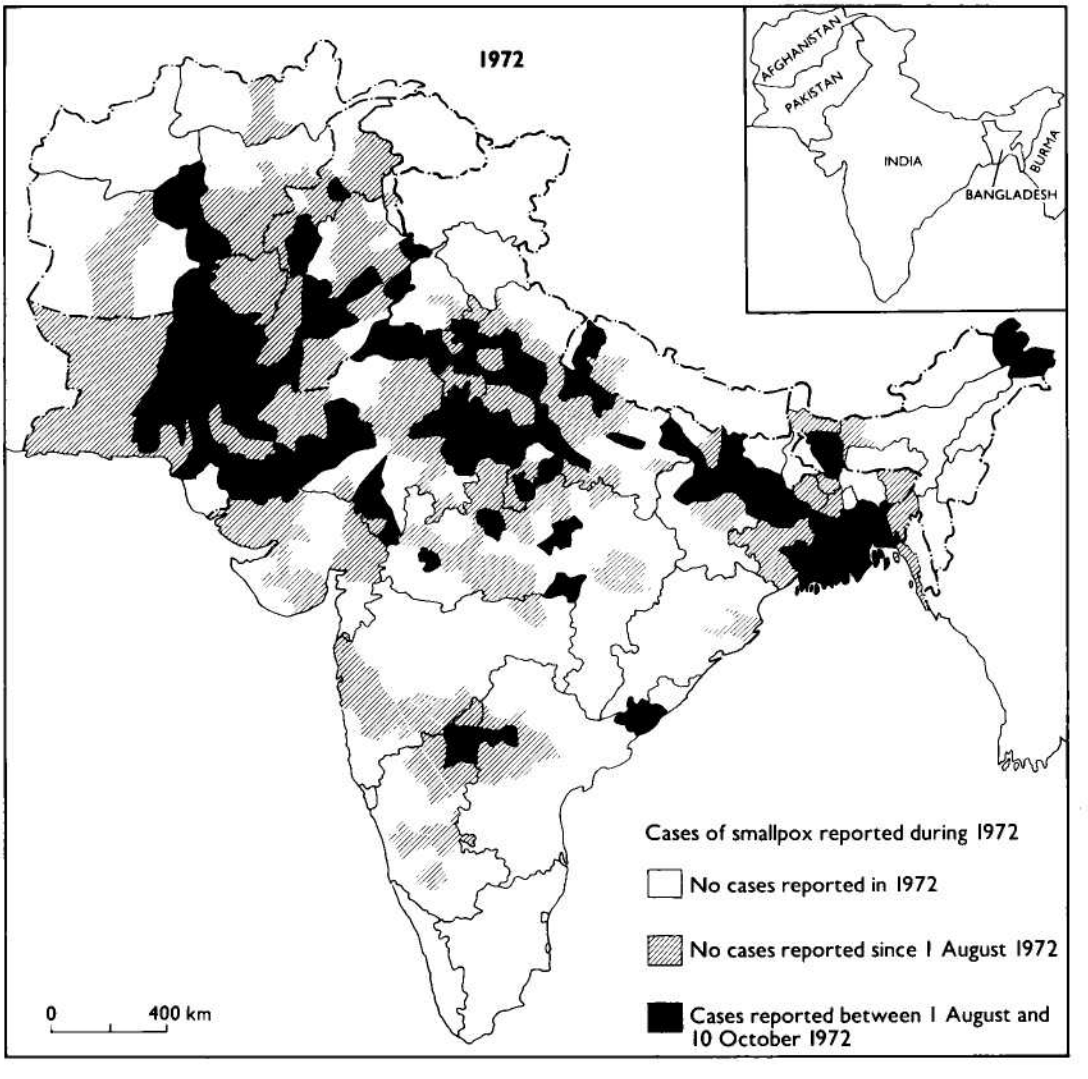


Fig. 15.11. Indian subcontinent and adjacent countries: areas reporting cases of smallpox during 1972 (as of 10 October).

while on the contrary, routine vaccination and mass vaccination campaigns had little effect in interrupting smallpox transmission'. That year, Indonesia reported 10 000 cases of smallpox, only 20% fewer cases than in India. Many at that Seminar took violent exception to the Indonesian director's contention that all available resources should be diverted to surveillance even at the expense of a vaccination campaign. Who was right? I would ask you to note that the number of cases in Indonesia decreased from 10 000 in 1970 to 2000 in 1971 and to 34 this year. Despite a continuing active search for cases, none have been found in all of Indonesia for over eight months."

State health authorities in India had argued that there were not enough health staff. However, it was noted that, even in countries

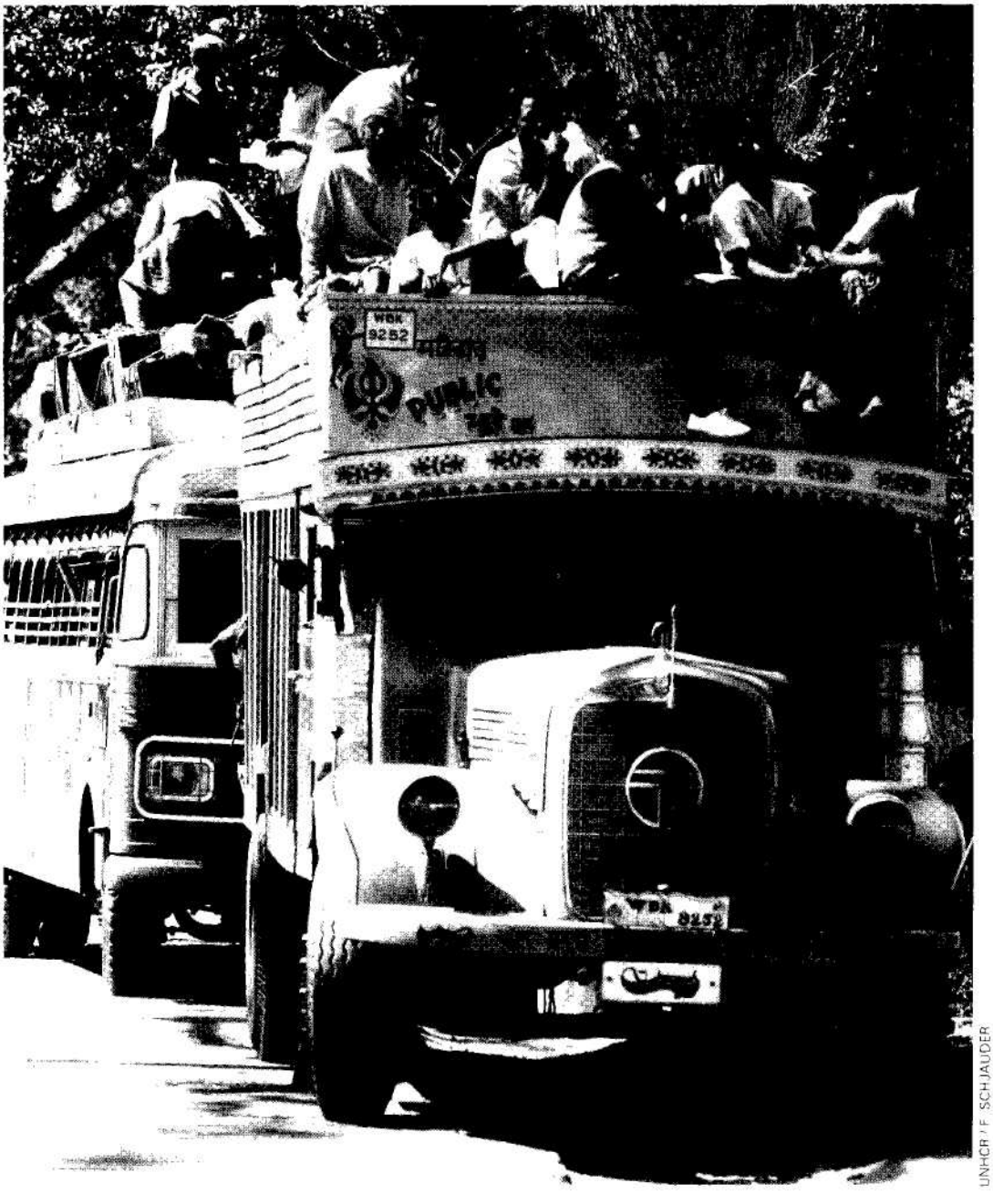


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**Plate 15.5.** Refugees from East Pakistan, many infected with smallpox, leave the Salt Lake Camp near Calcutta in December 1971 to return to their newly independent country, Bangladesh.

with less well developed health infrastructures, such as Ethiopia, only 80 workers were employed (1 for every 300 000 persons) and in Afghanistan the corresponding ratio was 1 for every 100 000 persons. In India, 1 smallpox vaccinator was available for every 8000–20 000 persons.

The need for surveillance was echoed in the address by the Indian Minister for Health and Family Planning and by Dr P. Diesh, the Additional Director-General of Health Services, who concluded the seminar with the statement: "History tells us that whoever rules the Indo-Gangetic plain rules the country. The battle of smallpox will be fought in the Indo-Gangetic plain, where 70% of the cases are reported now." And this indeed was where the major battle was fought over the following 3 years.

The seminar report concluded with a number of recommendations which stressed surveillance:

1. It is essential to delineate smallpox endemic and non-endemic areas within a state or country. The endemic areas should receive highest priority and the major part of the resources at present available. In the non-endemic areas, an active search for cases should be planned and implemented to ensure their smallpox-free status. Any suspected cases should be dealt with as a national public health emergency.
2. In states where surveillance teams are not yet in existence, state teams should be created by 1 December 1972.
3. The investigation of all outbreaks by the state programme officer or at least by state surveillance teams is essential.

Other recommendations emphasized the importance of containment and the need to trace the source of outbreaks. It was also noted that "the newly introduced reporting system in India should be improved as rapidly as possible". The new system was that previously described, in which primary health centres, districts and states reported weekly all cases of smallpox detected during a given week or reported "nil" if no cases were found.

The central programme office was further strengthened in the autumn of 1972, with the appointment of a senior public health officer to head the programme, Dr R. N. Basu, Assistant Director-General of Health Services (Smallpox), who continued in this position until the conclusion of operations. Dr Basu, who held a more senior rank than Dr Singh, carried greater weight with national and state officials. Dr Diesh, who was effectively second in command to the Director-General of Health Services in the Ministry, also took a special interest in the programme and made a number of visits to the state capitals to meet health ministers and directors of health services in order to encourage greater activity. Visits by an official of this rank were uncommon and implicitly indicated that the government accorded high priority to the smallpox eradication programme. Meanwhile, working relationships between WHO staff and Indian national and state staff had gradually become less formal. Arrangements for WHO staff from the regional office to travel to the field and for state-assigned staff to travel from state to state had become a simple matter of discussion and verbal agreement. This was in marked contrast to the earlier formal relationships which required that, before each trip, a written request should be submitted by the WHO Regional Director to the Ministry of Health and that this request should be considered within the Ministry and eventually a formal reply prepared—a process that often took weeks. With each adviser in possession of a vehicle purchased by WHO and an agreement by WHO to defray all travel costs, a further obstacle to the execution of the programme was removed.

1974

**Plate 15.6.** Rabinder Nath Basu (b. 1928), Assistant Director-General of Health Services, was appointed to direct the National Smallpox Eradication Programme in the autumn of 1972 and continued in this capacity until after the certification of eradication in 1977. He subsequently directed the development of India's Expanded Programme on Immunization and later became the Director of the National Institute of Communicable Diseases.

Z. JEŽEK

**Plate 15.7.** Outbreaks of smallpox occurred among poorly vaccinated pavement dwellers in crowded urban areas. The discovery and containment of such outbreaks were a continuing problem throughout the course of the Intensified Programme.

At the November seminar, goals were fixed in terms of geographical areas within which it was hoped endemic smallpox could be contained by the end of March 1973. For India, it was agreed that by that date the objective would be to eliminate endemic smallpox from all areas except the state of Bihar and 49 districts comprising parts of Uttar Pradesh, Madhya Pradesh and West Bengal.

As early as the end of December 1972, it was evident that the problems once again were greater than had been anticipated. As has been mentioned earlier, major epidemics were discovered in the previously smallpox-free state of Jammu and Kashmir. In Bihar State, health workers went on strike, bringing all work to a standstill. In Uttar Pradesh, then the principal focus of smallpox, eradication staff had been diverted to a cholera vaccination campaign. The new reporting system was an improvement over the old one but, even so, half or more of the states and union territories were consistently up to 5 weeks late in reporting cases.

During 1972, 27 407 cases of smallpox were reported from India, an increase of 69% over the 16 190 cases reported the year before. More complete notification undoubtedly accounted for some of the increase but there was no way of measuring the magnitude. In January 1973, predictions as to the expected incidence of smallpox in 1973 were made by WHO Headquarters staff, in consultation with national staff, on the premise that such predictions served to gauge familiarity with the problems in each area, the rate of progress being made or anticipated and the understanding of the epidemiological situation. It was forecast that 30 700 cases would occur throughout the world, of which 17 000 would be in India. It soon became evident that neither WHO nor Indian staff had comprehended the magnitude of India's smallpox problem.

By the end of March 1973, India had recorded 14 376 cases, of which 29% were outside the established target area. Not only were serious problems present in Bihar, Uttar Pradesh, and Jammu and Kashmir, but it had also become apparent that West Bengal had not done well in controlling the epidemic which had spread from the Salt Lake Camp area. By the end of February, 19 cases imported from Calcutta were detected in Orissa and 30 in Bihar. The estimate of the total number of cases in India projected for 1973 was revised upwards from 17 000 to 35 000

and then to 60 000, a figure which would represent the highest number of cases since 1967. Although reporting had undoubtedly improved, smallpox was far more extensive than had been expected; many still did not subscribe to the new strategy of surveillance and containment. During the spring of 1973, smallpox incidence continued to rise and by the end of June, 49 478 cases had been reported, of which 45 697 (92%) were from the 4 contiguous states in or immediately adjacent to the Gangetic plain—Bihar, Madhya Pradesh, Uttar Pradesh and West Bengal. The total number of cases was almost 3 times greater than the number recorded during the same period in 1972. Comparisons with trends in Pakistan and Bangladesh (*Wkly epidem. rec.*, 1973b) portrayed the unfavourable situation in India (Fig. 15.12).

India was then one of only 4 countries in the world with endemic smallpox, and it accounted for nearly 60% of the world's cases. Politicians and senior health officials alike had become increasingly concerned and had taken a greater interest in the programme. The Twenty-sixth World Health Assembly in May 1973 provided an added stimulus.

During discussions in the Health Assembly regarding the smallpox eradication programme, the delegate from Malaysia bluntly assessed the situation. His observations were summarized as follows (World Health Organization, 1973b):

"... an alarming development in recent months had been that serious smallpox epidemics were raging in two of the endemic countries, despite the fact that WHO was now entering the seventh year of its intensified smallpox eradication programme. Among the reasons for the setback, as given in the *Weekly Epidemiological Record* ... were: lack of staff; inadequately developed surveillance programmes; periodic diversion of smallpox staff to other programmes; delayed and incomplete reporting; and inadequate containment measures. Lack of staff should not be an insurmountable problem; it could be overcome by improved deployment of staff and crash recruitment and training programmes. Nor should it be too difficult to organize and develop surveillance programmes. In view of the vital importance of smallpox eradication, any diverting of staff to other programmes would be premature and ill-advised, and inadequate reporting and containment measures indicated a lack of appreciation of the urgency of the problem. He did not wish to criticize any individual country, but he hoped that the points he had raised would be taken in a constructive spirit.

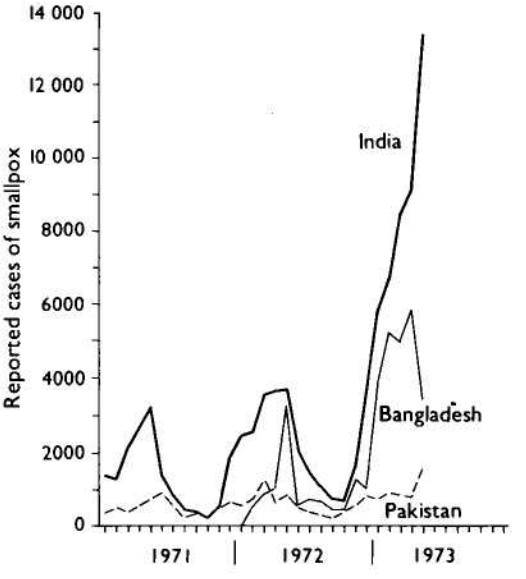


Fig. 15.12. Bangladesh, India and Pakistan: number of reported cases of smallpox, by month, 1971–1973 (as of 19 June 1973).

"WHO had declared that it was willing to send emergency aid on request ... to any country facing problems in smallpox eradication. He wondered whether the countries now suffering from outbreaks had taken full advantage of that offer ..."

In the World Health Assembly, criticism such as this of another country's health programme was unusual; to India's Director-General of Health Services, it was acutely embarrassing. He returned to India determined to strengthen the programme.

Endemic smallpox in India remained comparatively limited geographically (Fig. 15.13) although the number of cases was large, and it appeared that an intensified programme would require a special mobilization of resources in only a few states of India. With the season of diminished transmission immediately ahead, it was decided to initiate an "epidemic of activity" preceding the usual season of epidemic smallpox.

## The Intensified Programme in India, June–December 1973

At the end of June 1973, WHO staff from Headquarters and the Regional Office for South-East Asia held meetings with Indian national and state health personnel to devise a new campaign plan whose strategy would be to detect and contain the comparatively

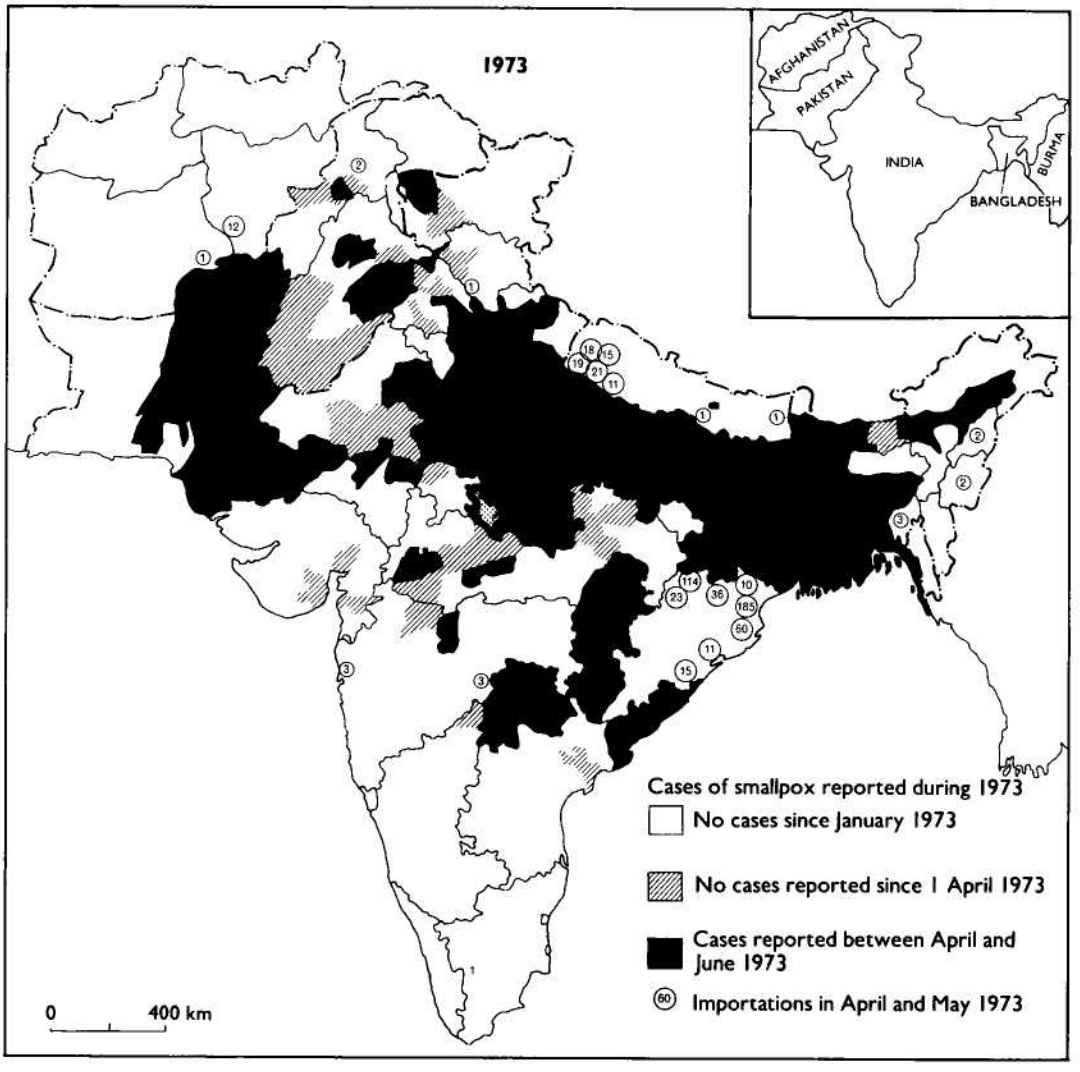


Fig. 15.13. Indian subcontinent and adjacent countries: areas reporting cases of smallpox during 1973 (as of 19 June).

few outbreaks expected to occur during the autumn months of seasonally low incidence. If most of these could be contained by December, it was expected that the remaining foci could also be contained by state and district surveillance teams during the January–June period.

The most highly infected states were Bihar, Uttar Pradesh and West Bengal. There, the deployment of an epidemiologist-adviser and a few surveillance teams for motivating local staff to report cases and to contain outbreaks had clearly failed. A different approach was required. The early detection of cases was of the greatest importance. Once cases were found, a comparatively small number of containment teams could deal with the outbreaks. Everyone had been impressed by the experiences in Gulbarga District (Mysore) and Muzaffarnagar District (Uttar Pradesh), in which it had proved quite simple to plan and execute a village-by-village programme of case detection which could reach all parts of a district within 1–2 weeks. It was reasoned that if a systematic search of this type could be conducted throughout entire states, in combination with an effective containment programme, it should be possible to contain smallpox quickly. To execute such a search in a state, in a group of states or in the whole of India posed problems of organization and motivation of an entirely

different magnitude from those involved in carrying out the operation in a single district. However, it was apparent that throughout the length and breadth of India a large complement of generally well-trained health staff existed—albeit often poorly supervised and supported. It seemed plausible that an increased number of senior smallpox eradication programme supervisors, following a carefully designed plan, could harness this considerable resource for a concerted effort over a period of a few months. This was the basic strategy decided on, and thus began what was to become one of the most ambitious and intensive national health programmes yet undertaken. Eventually, it would involve more than 130 000 staff who, within a 2-week period, could visit more than 90% of the 120 million households in India.

The principal problem area comprised the states of Bihar, Madhya Pradesh, Uttar Pradesh and West Bengal. Their combined population amounted to 249 million, or about 42% of the entire population of India. It was planned to assign a senior Indian epidemiologist and a counterpart WHO epidemiologist-adviser to assist each state smallpox eradication programme officer in these 4 states. An additional WHO epidemiologist would continue to work in the neighbouring state of Rajasthan, in which transmission appeared to have been interrupted but which was experiencing many importations. A sixth WHO epidemiologist would be based in Orissa State to assist in the development of search programmes and the investigation of outbreaks in the low-incidence states and union territories geographically close to the 4 highly infected states. He would also assist with any problems in a third group of states which were thought to have interrupted transmission or were expected to do so by September—the smallpox-free group (Fig. 15.14). Additional transport, supplies and equipment were made available by WHO to supplement the already considerable resources deployed by India.

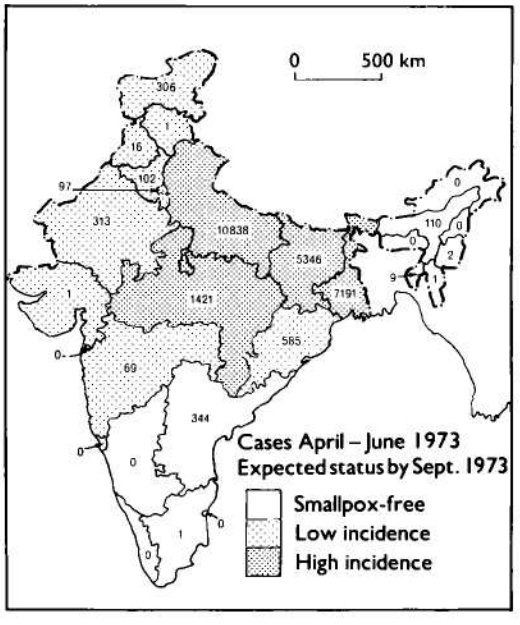


Fig. 15.14. India: autumn campaign of 1973. Number of reported cases of smallpox by April–June 1973 and the expected status of smallpox incidence, by state, in September 1973.

For the 4 highly endemic states, a 3-phase programme was formulated. Phase One, planned for the late summer of 1973, would consist of an active search for outbreaks in municipal areas. It was hoped by this search to find and eliminate urban foci, which often served to sustain smallpox transmission through the summer monsoon season. Because there was insufficient time for preparation, the first phase achieved little except to bring the smallpox eradication activities of most of the autonomous municipal corporations under the supervision of the state smallpox eradication programme office. Phase Two of the programme, from September to December 1973, would consist of statewide, week-long, village-by-village searches on 3 separate occasions approximately a month apart. Two searches would be conducted in the states with a low incidence, and at least 1 search in the states believed to be smallpox-free. Other health personnel and family-planning workers would be utilized to supplement the work of the smallpox eradication staff. The nature of Phase Three, commencing in January 1974, would depend on the status of smallpox at that time; it was expected that it would consist primarily of a search for cases by surveillance teams and the containment of a few remaining outbreaks.

The government of India and WHO agreed to increase the number of senior supervisory staff for this effort. The government provided an additional senior Indian epidemiologist for each of the 4 priority states. It assigned to the programme Dr M. I. D. Sharma, then the Director of the National Institute of Communicable Diseases; two of his epidemiologists, Dr C. K. Rao and Dr R. R. Arora; and the Assistant

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**Plate 15.8.** State review meeting in Lucknow, Uttar Pradesh, in 1975. *Seated, left to right*: M. C. Chaturvedi, Additional Director of Medical and Health Services of Uttar Pradesh; C. K. Rao, member of the Central Appraisal Team; J. M. McGinnis, WHO consultant from the USA; M. I. D. Sharma, Commissioner of Rural Health for India; and N. C. Grasset, smallpox adviser from the WHO Regional Office for South-East Asia. *Standing*: M. Dutta, member of the Central Appraisal Team.

Director-General for Cholera, Dr Mahendra Dutta. With Dr Basu and Dr Singh of the National Smallpox Eradication Programme, and Dr S. N. Ray, who was responsible for vaccine production, they constituted the Indian component of a group officially termed the "Central Appraisal Team". The WHO component consisted of the intercountry team (formally, the Smallpox Eradication and Epidemiological Advisory Team), Dr Grasset and Ježek, who were joined that summer by Dr William Foege, who had formerly worked in Nigeria and then at the Communicable Disease Center (later called the Centers for Disease Control) in Atlanta, GA, USA, in directing the smallpox eradication effort in western Africa. In January 1974, Dr Lawrence Brilliant, a new member of the WHO smallpox eradication programme staff, became part of the team.

Beginning in June 1973, the group held frequent meetings, preparing, reviewing, and revising drafts of a "Model Operational Guide for Endemic States" and a "Model Operational Guide for Non-endemic States". To implement the programme in the field, 26 special teams were created. Half the teams were headed by Indian epidemiologists recruited by the government from Indian institutes and universities or brought back from retirement. The other half were headed by epidemiologists of other nationalities recruited by WHO. Twenty-two teams were assigned to the high-incidence states (10 to Uttar Pradesh, 2 to West Bengal, 5 to Bihar and 5 to Madhya Pradesh); 2 teams worked in the eastern states; and the remaining 2 in the smallpox-free and low-incidence states in the south.

Eventually, a total of 230 epidemiologists from 31 countries and a comparable number