

Plate 10.29. Front of the WHO smallpox recognition card that was widely used from 1971 in endemic countries. Smallpox eradication workers searching for cases would show the card and inquire whether anyone had seen a person with a similar rash.



Plate 10.30. Reverse of the WHO smallpox recognition card. It was on heavy-duty A4-size paper and cased in plastic for protection, unlike the pocket-sized version shown in Plate 10.11. In Ethiopia, a variant was used that showed an Ethiopian patient with variola minor.



Plate 10.31. Schoolchildren in Somalia (A) and in India (B) are shown the WHO smallpox recognition card and asked if they know of cases. Information about possible cases within a radius of 10 kilometres or more was frequently obtained in this way.

burn all dwellings in which cases had occurred.

The WHO Handbook devoted only 7 pages to a discussion of proposed containment and disinfection methods; the latter, quoted from Dixon (1962), were impracticable and, indeed, scientifically questionable. For example: "Letters: (a) Iron separate pages, both sides; (b) Expose loose pages and envelope to formalin vapour for three hours, then seal." The Handbook recommended that, in countries reporting fewer than 5 cases per 100 000 population, responsibility for containment should be given to a "knowledgeable person", defined as a trained epidemiologist. It recommended that the patient should be isolated, the source of infection identified, and household contacts vaccinated as well as "several hundred to several thousand persons ... in a brief intensive effort". It had little to say about the practical problems of containment, since there was little information in the published literature and those responsible for writing it had no practical experience of their own.

The diligence with which the containment of outbreaks was pursued after 1967 paralleled, in general, the development of reporting systems. Experience in executing containment measures gradually accrued as the programme progressed, but up to the end of 1973 the measures taken were comparatively simple ones, quite different from the disci-

plined methodology which began to be applied during the concluding stages of the programme in Asia and Africa in 1974.

Field experience showed that the isolation of patients in their own home or in a separate dwelling was usually the best practice. Because there was no effective therapy for smallpox, the hospitalization of patients was of little benefit. Moreover, hospitalized patients frequently spread infection to other patients, visitors and staff because hospital administrations regularly ignored isolation procedures. In fact, the authors are unaware of any institution in any endemic country, except one hospital in Madras (India), in which proper isolation practices were followed until they were introduced by smallpox eradication programme staff. So prevalent was the problem that programme staff often referred to hospitals as "smallpox transmission hospitals". Precautionary procedures were comparatively simple—the vaccination of staff and visitors, the isolation of all smallpox patients in a special ward and the vaccination of all such patients to protect any who might have been misdiagnosed. In most hospitals, however, smallpox patients were regularly accommodated in infectious disease wards with patients with other diseases or, at best, intermingled with chickenpox patients. Visitors usually came and went as they pleased and hospital staff themselves were frequently unvaccinated. Even late in the course of



Plate 10.32. Search workers used loud hailer at weekly markets, such as this one in Ethiopia, to seek information about possible cases of smallpox.

national programmes, infection in hospitals continued to occur, the last cases in Brazil and South Africa, for example, having been infected in this way. Indeed, the last case of endemic smallpox, in 1977, was in an unvaccinated hospital employee.

In most countries, the isolation of the patient in his home was both traditional and satisfactory but, in some, social customs led to the infection of many susceptible persons. Among some groups in the Indian subcontinent, for example, it was traditional for relatives and friends to visit those who were very sick, and in Indonesia young children with smallpox were often carried from house to house to be seen and comforted by relatives. Not surprisingly, simple containment measures were ineffective in these areas and smallpox spread rapidly. Interestingly, the most effective practices of patient isolation were found among scattered, illiterate African and Asian tribal peoples, who often arranged for the patient to be housed in a separate dwelling and to be cared for by someone who had previously had smallpox.

Special disinfection procedures after the patient had recovered were uncommon except for boiling or burning the patient's clothing and bedding; hospital rooms were cleaned in the ordinary way. Because few cases appeared to result from contact with fomites, no attempt was made during the programme to alter customary disinfection methods whatever they were.

The vaccination of contacts and the "several hundred to several thousand persons" in the area was fairly perfunctory until the programme was greatly intensified in 1974. Such vaccination was usually conducted during the main part of the day in the course of outbreak investigation. Inevitably, a number of residents, including household contacts, were away from home or their village at this time and so remained unvaccinated. Nevertheless, in Africa and South America, this brief but incomplete vaccination effort was usually sufficient to contain the outbreak eventually, even though one or several generations of cases might subsequently occur. In some countries, as cases became fewer, teams began to vaccinate early in the morning and in the evening to ensure more complete coverage, but seldom was a systematic effort made to enumerate and vaccinate all residents.

Attempts to trace the source of infection were sometimes made but were not always successful, special skills and diligence being required in questioning the patient, his family and friends. It was especially difficult to obtain such information, for example, from persons engaged in illicit activities such as smuggling or from people who had acquired the disease from prostitutes. A few programme staff, however, acquired an unusual mastery of the technique of tracing sources of infection and prided themselves on being able to identify the source of every

outbreak. Conversely, there were some otherwise competent epidemiologists who were consistently unsuccessful in this task; a few, especially early in the programme, simply characterized most cases as "sporadic".

Surveillance and Containment Measures after September 1973

From September 1973, the nature of surveillance and later of containment measures began to change significantly. By then, comparatively simple surveillance-containment operations and mass vaccination campaigns had been successful in stopping transmission in all but 5 countries—Bangladesh, Ethiopia, India, Nepal and Pakistan. Even in these countries, simple surveillance-containment measures had successfully eliminated smallpox from large areas, including much of southern India, Nepal and Bangladesh. Lack of progress in northern India and Pakistan, however, made it clear that neither country was likely to stop transmission without a more concerted effort. In the summer of 1973, therefore, a more elaborate system for case detection and subsequently for containment was devised by WHO and Indian staff which would involve large numbers of health service personnel, larger numbers of WHO and Indian epidemiologists, and greater financial support. Similar intensified efforts began late in 1973 in Pakistan, early in 1975 in Bangladesh, towards the end of 1975 in Ethiopia, and in May 1977 in Somalia when smallpox again became endemic there following importations.

Surveillance

In India, the persistence of smallpox despite high levels of vaccinal immunity was attributed partly to the high population density and partly to the frequent suppression of reports of cases by health staff. When, in 1974, the sources of all outbreaks began to be more carefully investigated, it became apparent that there was a third factor of significance—the frequent spread of smallpox over long distances. Of 6227 outbreaks for which the source was identified in 1974-1975, 1129 (18%) were found to have originated outside the state in which the outbreak had occurred and 25 outside the country itself (Basu et al., 1979). By comparison, data from Ethiopia,

fairly typical of the experience in Africa, showed that the source of only 2% of outbreaks was outside the region (province) concerned (Tekeste et al., 1984).

It was believed that the key to eradication in the remaining affected areas was the more complete and the more prompt detection of outbreaks. Accordingly, it was decided to supplement the routine notification system by enlisting the participation of health staff from other programmes in national village-by-village, and eventually house-to-house, searches. Such searches had been shown to be effective in a district and in one state of India during 1972-1973 and, since large numbers of health staff were available in that country, it seemed reasonable to try to undertake them on a national scale. A detailed plan and guide were prepared which called for every inhabited locality in the search area to be visited in order to detect cases or to confirm their absence. In concept the plan was simple. The health staff in each administrative area would each be assigned 1-3 villages to visit each day. With the numbers available, an entire state could be covered within 7-10 days. After the search, the staff of the smallpox eradication programme, assisted by the local health workers, would contain the outbreaks which had been detected.

This proved to be feasible in Pakistan and Bangladesh as well as in India, but in Ethiopia and Somalia, with few health staff, temporary workers were required. Those from local ethnic groups, even the illiterate, who knew the topography and the people, proved to be the most effective—indeed, better than educated persons from urban areas. Considerable numbers were involved in each national search—more than 120 000 in India, 10 000-20 000 each in Bangladesh and Pakistan, and several thousands in Ethiopia and Somalia.

Training and motivating the large numbers of people involved were easier than had been expected. Training sessions of 1-2 days' duration were conducted before each search for personnel at the highest and intermediate administrative levels; subsequent sessions were conducted by intermediate-level supervisors for primary health centre supervisors, and, finally, by these supervisors for all health centre staff. Each intermediate and lower-level supervisor thus attended 2 training sessions, one as a participant and one as an instructor. At each meeting, the method of search was described

and, before the second and subsequent searches, the results and problems of the previous search were reviewed. The forms used were so designed that, when properly filled out, they guided each supervisor and search worker in carrying out his responsibilities.

The searches were conducted at different intervals in different areas—usually once every 4–8 weeks in endemic areas and once every 2–3 months in non-endemic areas. In the interval, additional search programmes were carried out in high-risk areas and in areas in which performance had been poor.

The development of a local search plan, in an area with perhaps 100 000–200 000 inhabitants, was the responsibility of the health officer in charge of that area. He selected the personnel to be employed and, using maps and demographic data, gave each worker 1–3 villages to visit each day on certain specified days. Those conducting the search travelled on foot or by bicycle. Some overlap in the sectors assigned helped to ensure that no areas were omitted. Usually, the workers travelled alone but in geographically difficult or dangerous areas a 2-man search team was used. A supervisor oversaw the work of 5–10 workers.

Through 1974, searches were conducted only in India and Pakistan and, until the autumn of that year, search workers were instructed to contact a number of different persons and groups in each village: the administrative head, postman, watchman and

other local figures; people working in health units; children and teachers in schools; owners and customers of tea-shops; frequenters of markets; and persons at temples, mosques, churches, bus stops and similar places where people gathered in large numbers. The inhabitants of clusters of houses in each of 4 sectors of a village were to be visited, as were those in the poorest area. Although the more diligent workers were able to carry out all these activities, many did so perfunctorily, with the result that a number of cases failed to be detected. Overall assessment of the activities proved difficult, as did the identification of those performing inadequately. In the autumn of 1974, the numbers of cases and outbreaks had decreased sufficiently so that the method of search could be changed to one of house-to-house visits. A reward was offered and each search worker was required to place a poster or to paint a notice publicizing the reward on every tenth house, as well as on the schoolhouse. The quantity of forms, reports and posters required for each national search was considerable, one estimate in India indicating the need for a total of 8 tonnes of paper.

To ensure that the proper questions were asked, each search worker was trained to use a particular approach: he was to introduce himself as a health worker, explain the reason for his visit, show the WHO smallpox recognition card, inquire about suspected smallpox cases and tell the people about the reward and where to report suspected cases.

When a suspected case of smallpox was found, the search worker immediately notified his supervisor or the nearest health unit so that a containment team could begin work. In Ethiopia and Somalia, in which the population was widely scattered, search workers usually carried vaccine and were instructed to begin containment vaccination when a suspected case was found. The periodic discovery of suspected cases was important in sustaining the interest of the workers, but in areas which had become smallpox-free, interest was sustained and a mechanism of assessment provided by requiring them also to look for cases of chickenpox and measles and to detect and report all deaths accompanied by skin rash. This also provided added assurance that smallpox had not returned.

Special searches had to be devised for Somalia and other areas such as the Ogaden desert in which groups of nomads were



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Plate 10.33. Checking a bus station in Chotanagpur, India, for cases of smallpox. Regular checks of travellers by surveillance teams provided information about possible outbreaks over a wide area.

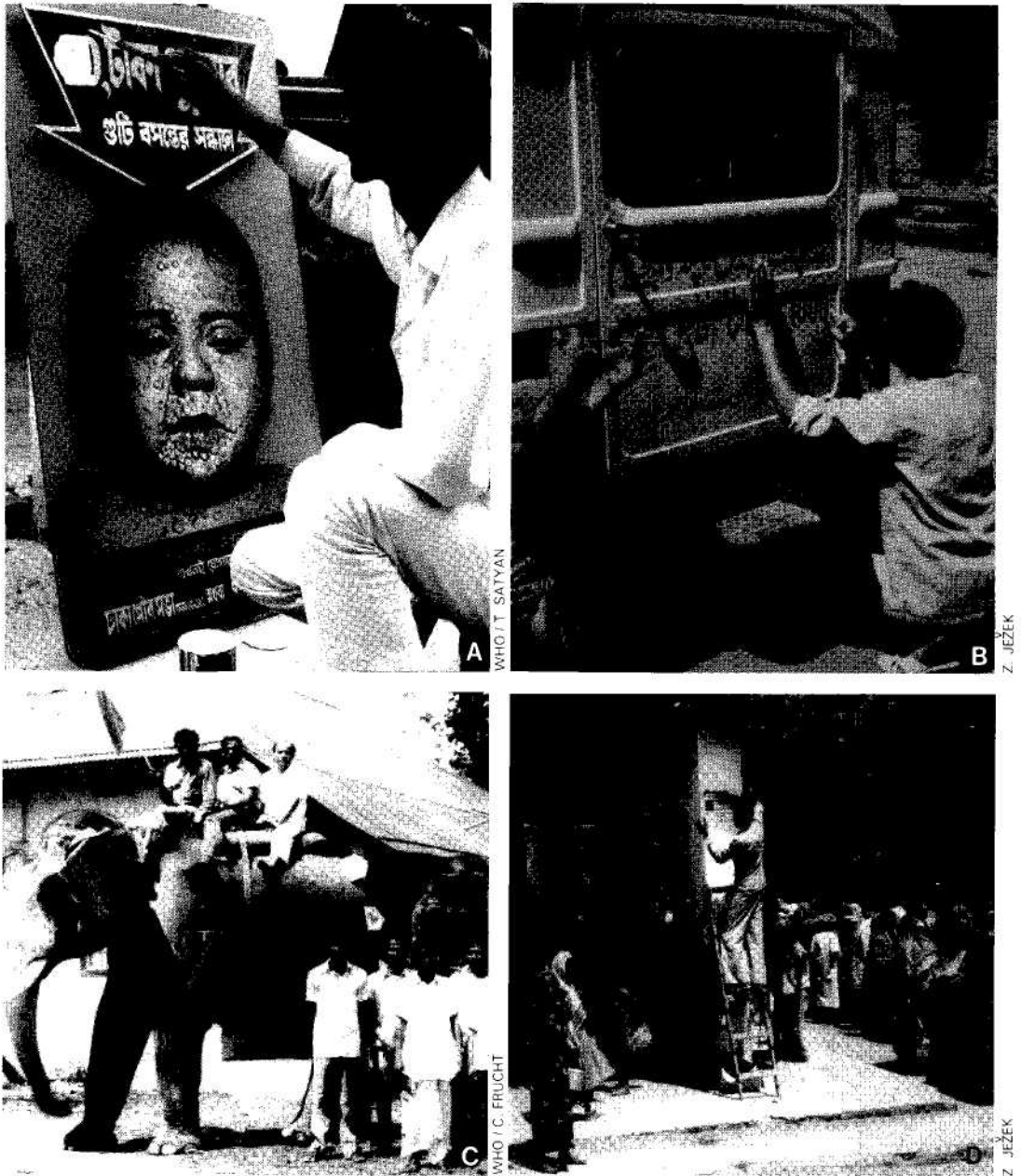


Plate 10.34. Publicizing the reward for reporting a case of smallpox. **A:** Repainting a poster in Bangladesh to show an increase in the amount of the reward. **B:** Painting a reward notice on a vehicle in Kashmir, India. **C:** Advertising the reward on an elephant in Assam, India. **D:** Hanging a reward poster in Somalia.

continually on the move. As is described in Chapter 22, different approaches were used to ensure the coverage of large areas while at the same time ensuring adequate supervision and assessment. In these areas, teams of 2 regularly walked long distances—50–150 kilometres—usually carrying vaccine so as to vaccinate any nomads encountered.

The organization of searches in urban areas was complex, and ingenuity was needed to coordinate the activities of the many and varied groups who usually participated, including numerous categories of municipal health staff and sometimes medical students, trainee nurses and volunteers from public services.

An intensive publicity campaign before and during the search, including the use of loudspeakers on cars and rickshaws, slides for projection, radio announcements, newspaper articles, handbills and posters, was found to be important in obtaining cooperation. As in rural areas, house-to-house searches were conducted, but schools, markets, factories and private medical practitioners were also visited. Special attention was given to areas in which migrants lived and to poor neighbourhoods. In urban areas, it was found that a search worker could visit 150 houses a day or about 1000 houses a week; 10 search workers with 2 supervisors were required to search an urban area with a population of 150 000.

Continuing assessment of search operations was as important as independent assessment of mass vaccination campaigns, as became apparent after the first search in India. Supervisors reported that 90% of villages had been searched and, indeed, thousands of previously unreported cases were detected, but a separate assessment by surveillance teams discovered that less than half the total had, in fact, been covered. An assessment programme was therefore developed which provided for independent appraisal of 5-20% of the localities by higher-level health officials and special teams. Where it was found that less than 85% of villages or urban sectors in an area had been searched, the entire search process was repeated in that area. As time passed, the minimum standard was raised to 90% and the areas chosen for assessment were deliberately selected to include those least likely to have been well covered, such as the villages furthest from health units and those with a high proportion of migrants or very poor populations. Similar approaches were adopted for assessment in the other countries.

The initial assessments were comparatively simple to make, being based on the statement of the village leader or the villagers themselves that a search worker had been in the area and the finding of a smallpox poster or marking on a wall (Plate 10.35). More sophisticated assessment became possible when house-to-house searches began and a reward was offered. Individual households were then asked whether they had been visited by a search worker, whether they knew the amount of the reward and whether they knew where to report cases of smallpox. Later, when workers endeavoured to detect cases of measles, chickenpox and other



WHO / P. ROBERTS

Plate 10.35. In some villages and towns, as here in Barisal, Bangladesh, search workers made a special mark on the wall of every fifth or tenth house. This was evidence for the assessment teams that the area had been visited.

illnesses with rash, the incidence of these diseases in different areas was compared and those in which few such cases were reported were searched again by special teams.

Assessment itself involved large numbers of people. In India, for example, 3 million households in 107 000 villages were routinely visited following each search. The numbers were smaller in Somalia, but finding the scattered villages and nomad camps made the task no less challenging.

The value of assessment in the search programme suggested its possible use for other purposes; this was demonstrated in Bangladesh (Joarder et al., 1980), in which teams also evaluated the availability and utilization of tube-wells in rural areas, contraceptive pills (and public awareness of family planning methods), and rural health centres. In other areas, data regarding the occurrence of measles, tetanus, poliomyelitis and blindness were obtained.

Surveillance teams were especially important in the planning and assessment of the search programmes and in other types of search procedure. Until 1973, there had been few of them in Asia, and they had been inadequately supervised and primarily responsible to state or district authorities; from 1973 to 1975, their numbers grew rapidly, proportionately more being assigned to areas in which smallpox was endemic. Those responsible for surveillance over the largest



D. PIBURN

Plate 10.37. The ceremonial presentation of a reward for discovering a case of smallpox in Kuralia, Bangladesh. The formality of a public occasion lent dignity to such events and attracted attention to the rewards.

contacted. The cards were subsequently useful in assessing the efficacy of search among nomads.

Special search programmes were required for areas especially difficult of access. Each country had a number of such areas, usually with a small, widely dispersed population and few health services, where teams often had to travel by boat, horse or camel or to walk for one or more weeks. Where *variola major* had been present, as in Asia, it was possible through facial pockmark surveys to determine the recent past history of smallpox. Such surveys in Bangladesh, India, Pakistan and Nepal during 1975–1976 revealed only a few small outbreaks which had occurred earlier but not been reported (Ježek & Kanth, 1978; Nair, 1978; Basu et al., 1979; Ježek et al., 1978b; Joarder et al., 1980). This was partly because of infrequent contact between the inhabitants of these isolated areas and those of the more populated endemic areas and partly because of the traditional practice of isolating patients that was followed by many tribal peoples.

The remote areas of Ethiopia and Somalia presented a different challenge. *Variola mi-*

nor had been present in these areas during recent decades, rarely leaving persistent facial pockmarks. Because the disease was mild, patients were usually not isolated and smallpox persisted for long periods. Repeated searches were required to confirm the absence of smallpox, and these were conducted in many areas of both Ethiopia and Somalia as well as in the southern Sudan (WHO/SE/74.67, Bassett et al.; Foster et al., 1978; Ježek et al., 1981; Tekeste et al., 1984).

Ultimately, the most effective method of ensuring prompt reporting proved to be to offer a reward. This had first been done in Indonesia in 1972, when a large outbreak was discovered in what was thought to be a smallpox-free area of Java (see Chapter 13). Numerous illnesses with rash were reported but none proved to be smallpox. Later that year the practice was adopted in Karnataka State in India, and soon thereafter in several southern states of that country, all of which were free or virtually free of smallpox. The rewards ranged from 10 to 25 rupees (US\$1.30–3.25). The practice of offering a reward was slow to be adopted more widely, however, because many national and state

Table 10.11. India and Somalia: sources of reports of outbreaks

Source of report	India, 1974-1975		Somalia, 1977	
	Number of outbreaks	% of total	Number of outbreaks	% of total
House-to-house searches	1 946	62	52	37
Field Investigations	928	29	9	6
Reports by members of the public	249	8	67	48
Other ^a	38	1	13	9
Total	3 161	100	141	100

^a Includes market searches and other special searches by teams.

officials feared that it would establish a precedent whereby a reward would be expected for the report of any illness. This fear proved to be unfounded.

At the beginning of 1974, most Indian states sanctioned a reward of 50 rupees (US\$6.25), rising to 100 rupees (US\$12.50) at the end of 1974 and to 1000 rupees (US\$125) in July 1975, shortly after the occurrence of the last case. The offer of even larger sums was considered but programme staff believed that too large a reward would cease to be credible. Even the amounts mentioned represented scarcely believable sums in a country in which workers were sometimes paid 10 rupees or less per day. Initially, the rewards were not well publicized by the health workers, who wished to keep them themselves; but the problem was resolved by offering 2 rewards, one for the person who reported the case and the other for the health worker who investigated it. Only 2 countries besides India offered a reward while cases were still known to be occurring: Bangladesh in mid-1974 and Somalia in April 1977. In Bangladesh, 220 000 takas (US\$27 280) were paid in all, a modest sum for the improvement in reporting which occurred. The total expenditure in rewards is not known for India or Somalia, but it is believed to have been substantially less than in Bangladesh.

Rewards were also offered in other countries after they became free of smallpox but, although many suspected cases were reported, none was confirmed. Finally, in 1978, the World Health Organization offered a reward of US\$1000 for the reporting of a case that could be confirmed; this, too, brought to light a great many suspected cases with rash due to many different causes. Although none proved to be smallpox, the offer of the reward was of value in confirming that eradication had been achieved.

Many approaches were used to publicize the reward but studies showed that the most

effective was simply for search workers and surveillance teams to talk to the people. In surveys in both urban and rural areas of India, 70-85% reported that they had learned about the reward from a search worker; even higher figures were recorded in Somalia.

In 1975, when smallpox incidence had decreased to very low levels, other techniques were used in case detection. Health centres and hospitals were asked to enter the names and addresses of all suspected cases in a "rumour register" so as to obtain a record of such cases which could later be checked by surveillance teams; specimens were taken in increasing numbers from patients with chickenpox in order to ensure that errors in diagnosis were not being made; and surveys were conducted over wide areas to detect persons with facial pockmarks in order to determine whether any had had smallpox after transmission had apparently been interrupted. These activities continued throughout the certification period and were among the important steps taken to certify that transmission had been interrupted (see Chapter 24).

Of the many methods used to detect cases after 1973, in India house-to-house search was clearly of the greatest importance, followed by field investigations of the cases detected (Table 10.11). In Somalia, however, reports from the public in response to the offer of the reward previously mentioned were more important, that offer having begun to be publicized in April 1977 before house-to-house searches had been organized. Because of the reward, young nomads found it profitable to search widely for cases and many reports were received from them.

Containment measures after September 1973

In the change of strategy which began in the autumn of 1973, the initial concern was to ensure the prompt and more complete

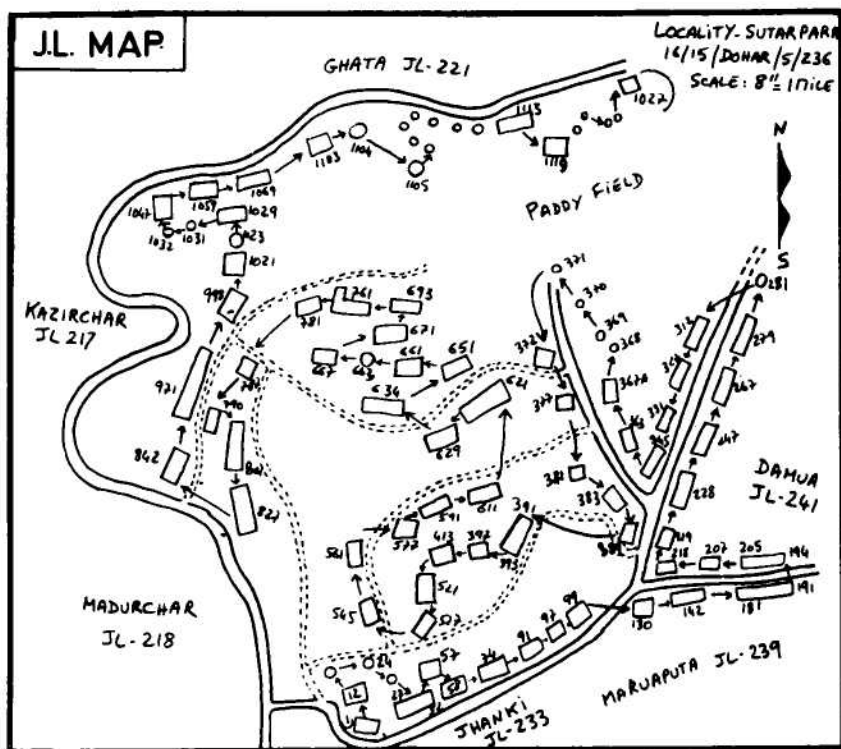


Plate 10.38. A sketch map of an infected village, prepared for containment activities in Bangladesh. All the houses were numbered; arrows indicated the order in which the houses were to be searched.

detection of cases. It was expected that the outbreaks could then be effectively contained by smallpox eradication staff in the conventional manner. The discovery of more than 10 000 cases in India during the first search in 1973 was unexpected and, in many areas, the numbers of outbreaks proved to be far beyond the capacity of existing staff to deal with. In heavily infected areas, help was at first sought from existing health staff but this often proved counterproductive, since those who discovered cases soon found themselves burdened with the additional task of containing the outbreaks. Accordingly, arrangements were made to ensure that those who searched were not also responsible for containment.

Because of the difficulties in developing search operations and the large numbers of cases, containment in all countries until the summer of 1974 continued to consist in little more than the isolation of the patient, a rapid survey to detect additional cases, and the vaccination of household contacts and those in some 30 surrounding households. It gradually became apparent that these measures were inadequate, since outbreaks which were thought to have been contained not

only persisted but also spread to other areas. That summer, as numbers of smallpox cases decreased substantially, it became possible in India to assess carefully the failures in containment and to develop special measures to correct them. Over the succeeding months, containment measures became increasingly stringent, making it necessary to engage many additional workers, often locally recruited and trained. Other countries subsequently adopted similar measures.

Measures were taken to ensure more complete vaccination coverage in the outbreak area, the first step being to assign responsibility for each outbreak to a team leader who was a member of the smallpox eradication programme staff. He prepared a sketch map of the affected locality (Plate 10.38) and employed a team of local health workers to paint numbers on the doors of the houses or, in the case of tents, on WHO smallpox recognition cards, which were then attached to the entry flap of each tent. All residents of the village or district of a town were listed by name and by house before containment vaccination was begun, since it was found that fewer persons were then successfully hidden in an effort to avoid

vaccination. The vaccination programme, which followed the listing, required 1-3 days, the team leader and a number of vaccinators remaining in the village for 1 or more nights so as to vaccinate those who were absent during the day. Eventually, a vaccinator remained in an infected village for 28 and, later, for 42 days following the onset of the last case in order to vaccinate visitors, ensure that the patient remained isolated and detect promptly any additional patients who had been vaccinated too late in the incubation period to be protected. In Somalia, 1 or 2

vaccinators usually travelled with each affected group of nomads throughout this period.

For areas outside an infected village but within a radius of 8-10 kilometres, other teams moved from house to house to search for cases and to vaccinate. Because of the density of the population in many of the infected areas in Asia, this sometimes meant contacting 10 000 or more persons, a process that often took 1-2 weeks.

Wherever possible, patients were isolated in their houses, but even this required special measures. To ensure isolation, 4 guards were



WHO



M. BELKEND, 1974



WHO, P. ALMAMY

Plate 10.39. **A:** Programme staff move from house to house to seek out cases and to register all persons resident in an Indian village. **B:** A WHO epidemiologist, L. B. Brilliant, shows the smallpox recognition card in Bihar State, India, and inquires about possible cases in the area. **C:** A surveillance worker records the discovery of an 8-year-old boy with smallpox in Sidamo, Ethiopia.

hired who were instructed that at least one of them must remain at the door of the house, day and night, entry being permitted through a single door, the other doors being nailed shut. They made certain that the patient remained in the house, vaccinated all visitors and brought the necessary food, water and firewood to the patient. Two at a time were expected to be on duty during each 12-hour

period so that, if one had to leave, the other would remain. They stayed until the patient's last scabs had separated and were paid for their services at that time. Supervision was simplified by telling them that if, at any time, a supervisor found the house unguarded, all would be discharged without pay and new guards hired. Eventually a special book was provided in which the guards recorded the

A
E. SHAFIAB
L.N. KHODAKEVICH

Plate 10.40. **A:** A smallpox isolation hut in Baidoa, Somalia. **B:** An isolation camp for smallpox patients in English Bazar, West Bengal State, India.

name of each visitor, the date and the fact that he or she had been vaccinated.

In Ethiopia and Somalia, where many people lived in tents or small huts, and in congested areas of Bangladesh, it was difficult to isolate patients in this manner. In these countries, therefore, 2 other methods were sometimes used. The first was to construct for the patient a small separate hut with kitchen and latrine facilities and to surround it by a barrier of thornbush or bamboo. The second was to isolate the patient in a specially constructed camp occupied only by smallpox patients. Special guards were used in both cases. It was often difficult to gain the agreement of Ethiopian and Somali patients to be isolated, however, because, having the mild variola minor variety, they had few symptoms and could work and move about without difficulty. Compliance increased when all patients, on recovery, were given new clothes, their old clothes then being burnt.

From early 1974 onwards in India and later in Bangladesh and Somalia, larger numbers of national and international epidemiologists were recruited to head surveillance teams, with the aim of providing at least 1 such team for the supervision of surveillance and containment in an area with no more than 25 active outbreaks, an outbreak being defined as the occurrence of 1 or more cases of smallpox in a geographical location, such as a village, district of a town or nomad encampment. When a patient moved from one village to another—to be hospitalized, for example—this was counted as 2 outbreaks, since both areas had to be kept under surveillance. Once an outbreak was identified, it was considered "active" until 28 (later 42) days after the onset of the last case of smallpox. By this time, the patient's last scabs would have separated and any contacts who were incubating infection would have developed disease.

The surveillance teams were responsible for visiting each outbreak at least weekly to ensure that the prescribed measures were being taken; when the appropriate interval had elapsed after the onset of the last case, they were also responsible for organizing a search of the area lasting 1-2 days before certifying that the outbreak could be removed from the master list of active outbreaks.

Outbreak investigation required time and patience in order to identify with accuracy

the dates of onset of all cases and the probable sources of infection of each so as to reconstruct its development. For this purpose, and to promote an understanding of the concept of the chain of transmission, a special form had been employed since 1970. As the number of epidemiologists increased and the number of outbreaks decreased, more elaborate forms began to be used.

The surveillance team was responsible for investigating the source of infection or contacts of patients if they were in villages within its area of responsibility, but if the villages concerned were outside its area, the team notified its superiors so that other teams could investigate. However, the transmission of accurate information from one area to another regarding possible sources of infection and patient contacts proved unexpectedly difficult. The names of contacts as well as those of towns and villages often had to be spelled phonetically, since informants were usually illiterate. Whether this information was transmitted by telex, messenger or telephone, there were often difficulties in locating the persons or even the villages named.

The quality of supervision provided by the teams was proportional to the number of outbreaks and, as outbreaks became fewer, ever more intensive measures were applied, with the result that smallpox incidence showed an accelerating decline from June 1974 in India, and from the spring of 1975 in Bangladesh, when a similar approach was used there.

Measurement of progress

As has been noted above, it became the practice in 1973-1974 to record and monitor the number of active outbreaks rather than the numbers of reported cases. This focused the attention of programme staff specifically on surveillance-containment activities and, as a result, several standards for use in measurement were developed, designed to appraise the effectiveness of such activities.

The interval between the onset of an outbreak and its detection reflected the effectiveness of case detection. It was believed that it should be possible to detect at least 75% of all outbreaks within 14 days after the onset of the first case. This proved difficult. In India, a level of 57% was achieved during 1974-1975; in Bangladesh just over 70% in 1975; and in Somalia, 60% were discovered after intensive activi-

APP No. :- 9
Total House :- 77
Population :- 589
Vacc. PVIR RV 446

SMALLPOX OUTBREAK FIELD FORM

STATE: BIHAR, DISTRICT: BHARANAGARH, PHC/BLOCK: NAYANAGAR, VILLAGE/TOWN: CHARAN

Case No.	Name	Age	Sex	Date of		Vaccination scar present		Case No.	Name	Age	Sex	Date of		Vaccination scar present	
				Onset of rash	Death	Yes	No					Onset of rash	Death	Yes	No
1	HARSH RAM	5	M	26.12.74			✓	11	CHANDRATI	4	M	11.1.75	15.1.75		✓
2	GHANU	7	M	11.1.75			✓	12	MIRAMANI	9	F	1.1.75			✓
3	JHAMATI	3	F	13.1.75			✓	13	PHULHATI	6	F	16.1.75	22.1.75		✓
4	SOMA KUMARI	8	F	23.12.74			✓	14	PARAG	10	M	26.12.74			✓
5	GURUL	5	M	1.1.75			✓	15	MALTI	5	F	26.11.74	2.12.74		✓
6	SHIBU	3	M	9.1.75			✓	16	SHANTI	3	F	9.12.74			✓
7	PRANSHU	1	M	11.1.75	15.1.75		✓	17	LACHMIA	46	F	17.1.75		✓	✓
8	RAMPYARI	10	F	14.1.75			✓	18	KANAL	3	M	3.2.75			✓
9	MUNDA KUMARI	2	F	13.1.75			✓								
10	MEENA KUMARI	5	F	25.12.74	1.1.75		✓								

DAILY GRAPH SHOWING CHAIN OF TRANSMISSION IN OUTBREAK

Supervisor: _____ Date of Investigation: 17.1.75 Outbreak No.: 115/75

Plate 10.41. Form for outbreak investigation which provided in the upper part for basic data about cases and, in the lower, for plotting them by date of onset to show the spread from patient to patient. The roman numerals indicate the generations of cases. The outbreak plotted here occurred in Bihar State, India, in December 1974 and January 1975.

ties began in April 1977. However, by determining why in each instance the interval was longer than that prescribed, problems in detection were identified and the necessary changes in field operations could be made.

The response of containment teams was measured by the *interval between the discovery of the outbreak and the beginning of containment activities*. Ideally, containment should have begun on the day a case was reported, but this depended on the availability of manpower and transport. In most areas, there was a rapid response. In India, containment was started in 60% of newly discovered outbreaks on the day they were discovered; in less than 10% was it delayed for 3 days. In Somalia, containment was started on the day of discovery in only 40% of outbreaks when the programme began in April 1977 but in more than 90% by August.

The effectiveness of containment measures was assessed by the *interval, in days, between the beginning of containment and the occurrence of the last case*. This indicator was closely followed in all programmes from the autumn of 1974

onwards. The standard laid down was that no case of smallpox should occur in any outbreak more than 20 days after containment had started. This interval was long enough for containment vaccination to be completed and for smallpox to develop among those who had been vaccinated too late in the incubation period to be protected. From early in 1975, all outbreaks in which cases occurred more than 20 days after the start of containment activities were investigated by a senior epidemiologist to determine the reasons for failure and to advise on corrective measures.

The effectiveness of containment varied widely from area to area but improved with time. In India, additional cases occurred after 20 days in 25–30% of outbreaks in 1974, but in only 5% during 1975. In Bangladesh, a more rigorous interval of 15 days was prescribed as the standard. From November 1974, cases occurred in 25% of outbreaks after 15 days, a proportion which gradually decreased to less than 10% by June 1975. In Ethiopia, in 1973, smallpox persisted for more than 20 days in fewer than 25% of

outbreaks and the figure remained at or below this level until transmission ceased.

CONCLUSIONS

Smallpox had many attributes which greatly facilitated its elimination; the strategic plan for eradication was a comparatively simple and inexpensive one; and, in principle, all countries supported the concept of an eradication programme coordinated by WHO. As has been pointed out in this chapter, however, implementation of the smallpox eradication programme was neither simple nor straightforward, and its successful outcome, even as late as 1976-1977, was by no means assured. The execution of this global programme, like that of any other, was inevitably complicated by a host of natural and political problems ranging from floods, drought, famine and war to such human failings as incompetence, dishonesty and personal antagonisms. These alone gave rise to formidable difficulties. No less of a problem was that of obtaining and sustaining a commitment to the programme on the part of national governments and international agencies alike, however beneficial for all peoples the global eradication of smallpox was seen to be. In consequence, serious shortages of resources and lack of cooperation continually hampered progress. Although an understandable scepticism prevailed at first as to the feasibility of eradicating this or any disease, problems persisted even when it was clear that eradication was imminent and continued throughout the process of certification.

Nevertheless, the global eradication of smallpox was ultimately achieved, a success which can be attributed essentially to four factors. The first and most important of these was the existence of an international organization through which a collective international policy could be expressed and which could call on governments and individuals in fostering and coordinating activities directed towards a common purpose. Although the execution of the programme was sometimes less than optimum, no other agency could have obtained the requisite cooperation and international commitment and participation to achieve an objective of this magnitude.

The second important factor was the dedication and competence of a substantial cadre of both national and international staff,

many in their 30s and 40s, who continually learned from experience—adapting, innovating and creating to enhance the programme's activities. They, in turn, served to stimulate and to inspire the large number of national health staff whose potential had never been fully realized.

The third factor was that the strategic plan was stated in terms of principles and illustrative methodologies rather than of directives. Moreover, the WHO Handbook explicitly encouraged programme staff to explore alternative approaches and anticipated that changes would be made as experience was acquired. As a consequence, each national programme was different and each evolved and changed over time. In addition, experiences and observations in one area were rapidly communicated to others and then appropriately adapted and applied.

Finally, the fourth factor was the recognition in 1967 that, however much was known about smallpox and however adequate the tools for eradication appeared to be, continuing research both in the field and in the laboratory would be essential. Thus, research was actively promoted throughout the course of the programme and scientists from all parts of the world responded to WHO's requests with extraordinary generosity and commitment, commonly making their observations available long before publication. Without the contributions provided by research, the achievement of smallpox eradication would have been doubtful at best.

The programme itself developed with surprising rapidity from 1967 to 1973, employing few international staff and comparatively straightforward methods of mass vaccination and surveillance-containment. In large measure, this success, where earlier efforts had failed, can be attributed to the use of quality control in the programme, something that had been uncommon in most of the endemic countries. Testing in international laboratories ensured that vaccine was potent and stable; assessment of vaccination campaigns determined whether the proportion of vaccination takes was satisfactory and the coverage adequate; and improved reporting systems provided evidence of progress towards the ultimate objective of the programme—the absence of smallpox cases.

In 1973, when endemic smallpox was confined to 5 countries in the Indian subcontinent and eastern Africa, increasing resources became available through voluntary

contributions, permitting an intensification of work in the problem areas. Surveillance-containment programmes in the 5 countries concerned became steadily more sophisticated and activities began to be documented in greater detail. Increasing numbers of international and national staff were recruited for full-time service and printed forms for recording data increased markedly both in number and in the amount of detail they contained. Without this effort, smallpox transmission would have persisted far longer than it did, if indeed eradication could have been achieved at all, given the population density and movements of peoples in the Indian subcontinent, war in Ethiopia, and the suppression of reports of smallpox in Somalia.

Until 1973, successful national programmes required only a few international advisers in addition to their own health personnel, and a handful of simple forms. Case detection and containment programmes were simple and relied heavily on existing

health service units. This is not adequately reflected in the published literature, as most papers deal with programmes during the period 1973–1977 and suggest a pattern of activity which, although necessary then, was not characteristic of programmes in the more than 20 countries which succeeded in eradicating smallpox before 1973.

Chapters 12–22, which deal with national programmes, describe more fully the wide variety of activities carried out, the problems, the successes and the mistakes. What was apparent in all, however, was the potential for extraordinary achievement on the part of WHO and national health service staffs acting in concert, given proper guidance and appropriate support in coordination, management and the allocation of resources. The potential for success in eradicating smallpox was greater in 1967 than anyone initially believed; the potential for successfully applying measures for the control or elimination of other diseases is far greater 20 years later.

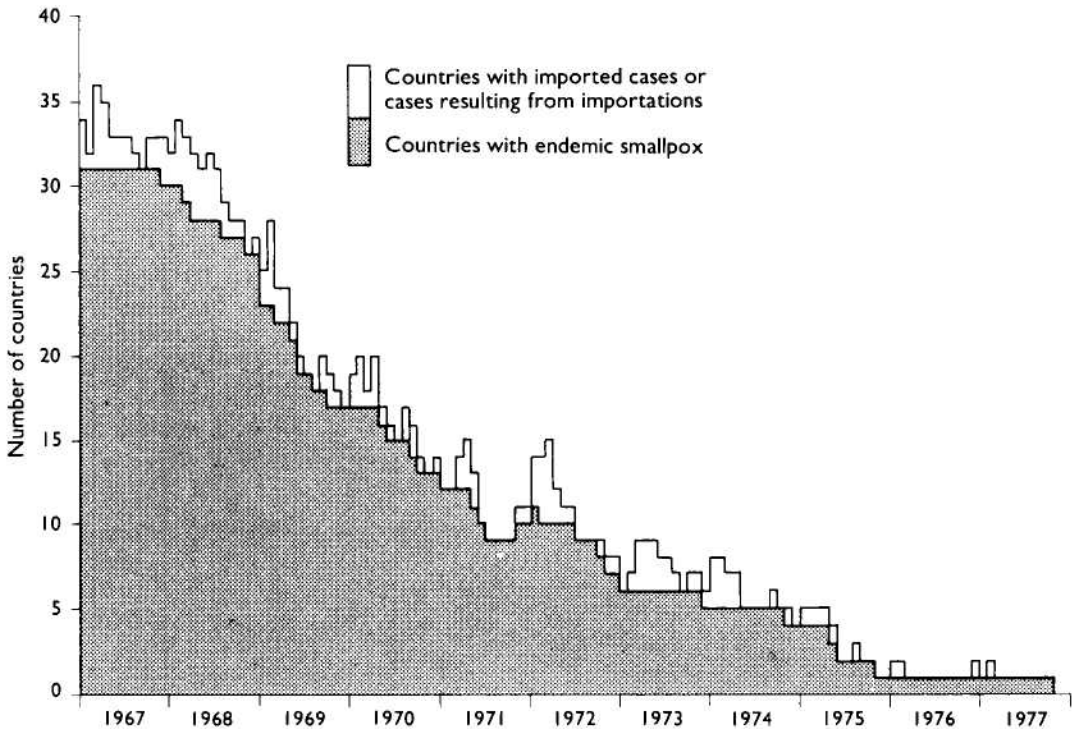


Fig. 10.4. Number of countries with endemic or imported smallpox, by month, 1967–1977.