



REINVESTIGATION OF SMALLPOX OUTBREAKS

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SUMMARY

An organized epidemiological reinvestigation of smallpox outbreaks detected since January 1975 was carried out at the end of 1976 in 20 Indian States and Union Territories. A total of 353 smallpox outbreaks in 335 localities having 1212 smallpox cases were reinvestigated.

In spite of extensive epidemiological investigation carried out in these affected localities and in those having a common border with the affected one, interviews held in more than 128 000 households and checking more than one-quarter of a million persons, no information about hidden foci could be collected. Moreover, no unknown smallpox focus which might have occurred in 1975 could be detected.

INTRODUCTION

An organized epidemiological reinvestigation of all smallpox outbreaks detected since 1 January 1975 was carried out in India at the end of 1976. These smallpox outbreaks occurred in 55 out of the 397 districts in the country. In addition, it was proposed to reinvestigate the last smallpox outbreak which occurred in each State or Union Territory of India, if the date of onset of the last case in the outbreak was after January 1974.

The objectives of these reinvestigations were:

to detect any unreported case of smallpox or rash and fever death and to ensure that no previously unknown smallpox transmission existed in the area after the last known case. This would be done by careful epidemiological interviewing and by conducting a facial pock mark survey;

to assess by means of a vaccination scar survey, the effectiveness of the containment operation carried out in the area;

to confirm that no hidden smallpox foci exist in these high risk areas by collecting information of fever and rash cases/deaths and by "on-the-spot" investigation and verification of detected cases.

MATERIAL AND METHODS

Table 1 shows by separate State or Union Territory the number of smallpox outbreaks which occurred since 1 January 1975.

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TABLE 1. AREAS AND OUTBREAKS SCHEDULED FOR REINVESTIGATION

State/Union Territory	No. of districts selected	No. of outbreaks detected in 1975	No. of outbreaks actually reinvestigated
Assam	6	18	19
Bihar	20	162	175
Gujarat	1	11	13
Madhya Pradesh	0	0	1
Meghalaya	1	22	22
Orissa	1	1	1
Tripura	2	4	4
Uttar Pradesh	15	50	55
West Bengal	9	43	49
Total	55	311	339

The reinvestigation operation was conducted by state surveillance teams, junior medical officers' teams or by special epidemiologists operating in the affected area. They were assisted by local health staff and the entire operation was organized and supervised by the smallpox programme officer of the State or Union Territory concerned. In the majority of states, the reinvestigation was conducted at the end of 1976 (October-December).

SMALLPOX OUTBREAK REINVESTIGATION - SCHEME OF WORK OF INVESTIGATING TEAM

Place visited	Time	Activities to be carried out
1. District Health Office	first day	To check level of reporting. To check record keeping.
2. Primary Health Centre/ Municipality	first day	To check level of reporting. To check record keeping.
3. Affected locality: (i) household affected (ii) 50 surrounding households (iii) remaining households in the village	first day second day	To check smallpox cases. To check other household members for facial pock marks, vaccination scars. Information about fever/rash death. To check household members for pock marks and vaccination scars. To collect information about fever and rash deaths. Pock mark survey in the remaining households. Information about fever/rash deaths.
4. Three villages (nearest to affected village)	second day	Pock mark survey in selected households

A pock marked child or person was defined as a child or person having at least five round, depressed facial scars which were 2 mm or more in diameter. Such a person was further carefully interviewed about the nature of the skin changes, about a possible history of smallpox, and their previous vaccination status.

Each team was asked to spend at least one night in the affected village or in the immediate vicinity in order to perform the most thorough investigation possible. On average, two to three days were necessary to complete all the prescribed actions in a previously affected village and in the surrounding area.

RESULTS

TABLE 2. REINVESTIGATION ACTIVITIES - SMALLPOX FOCI 1975
(INCLUDES 28 FOCI CONTAINING AN ACTIVE CASE AT THE END OF 1974)

State	Number of investigated				Smallpox		
	Dist.	Blocks	Localities	Outbreaks	Cases	Deaths	Households affected
Assam	6	9	19	19	90	11	46
Bihar	20	79	175	175	559	84	381
Gujarat	1	3	4	13	16	3	14
Madhya Pradesh	1	1	1	1	10	4	5
Meghalaya	1	8	22	22	61	9	39
Orissa	1	1	1	1	1	0	1
Tripura	2	2	4	4	9	1	4
Uttar Pradesh	15	35	55	55	278	46	179
West Bengal	16	35	40	49	142	23	86
Total	63	173	321	339	1 166	181	755

In addition to these 339 outbreaks, a further 14 smallpox outbreaks, which occurred in the States of Andhra Pradesh, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Punjab, Rajasthan, Tamil Nadu and in the Union Territory of Arunachal Pradesh and which had the last case after 1 January 1974, were also reinvestigated (Table 5). This made a total of 20 States and Union Territories comprising 353 outbreaks, having 1212 smallpox cases and resulting in 192 deaths, investigated in 335 localities (villages or town agglomerations) in 187 development blocks. Altogether, 75 districts from the total of 397 in India were involved shown as in Fig. 1.

Active foci in 1975

The 339 outbreaks which had active smallpox cases since 1 January 1975 and some of those still pending on the list of active outbreaks at that date occurred in nine States mainly located in the central or eastern parts of the country.

Size of affected localities:

<u>Population</u>	<u>% of outbreaks</u>
<500	36
500-1000	24
1001-2000	17
2001-5000	17
> 5000	6

(i) Households affected

Of the 339 foci, 775 household units were identified as having been affected by smallpox, of which 710 (94%) were visited by the investigating team. The household members were enumerated, interviewed and physically checked for pock marks and vaccination scars. There were 5799 household members enumerated, consisting of 1166 former smallpox patients and 4633 other members, but only 3979 persons (69%) were actually seen and personally checked. Of the total of 1166 smallpox patients recorded, 181 (16%) had died during the outbreak and 191 had permanently left the affected locality. Therefore only 779 smallpox patients who were present in the localities at the time of reinvestigation, could be interviewed and checked.

Total household members checked was 3979 of which no vaccination scar was present in:

previous smallpox cases	521 (13%)
child less than two years	169 (4%)
escaped containment vaccination	74 (2%)
Total	764 (19%)

Of 803 persons detected with facial pock marks, 667 suffered from smallpox in 1975 and 136 persons suffered in previous years. Of these there were 14 children younger than two years old and also having facial pock marks. Detailed investigation discovered that 10 of them suffered from smallpox in the period between December 1974 and April 1975 and were recorded as patients. The remaining four children had been misclassified having been affected by smallpox in 1974 when aged about two years, but were now three to four years old at the time of reinvestigation. Only five persons were found with pock marks who gave a history of having smallpox in 1975 and yet who were missing from the list of known patients. It is interesting to note that about 16% of patients known to have suffered from smallpox in 1975 were found without distinct facial pock marks an average of 20 months after their attacks.

Eight fever and rash deaths which had occurred during the previous 20 months were discovered and reported by members of the 755 affected households. Careful epidemiological investigations revealed in each case a clear history of measles or chickenpox among other family members or in neighbouring households at the time of death.

(ii) The households surrounding the affected ones

The investigating team visited 25-50 of the nearest households surrounding the affected one and checked household members for vaccination scars and facial pock marks. They also investigated all rumours of fever and rash cases or deaths which had occurred one-and-a-half years prior to the reinvestigation.

Of 15 486 such houses visited and 101 974 household members enumerated, only 59 214 (58%) were actually seen and checked.

Altogether, 2469 persons were found to have distinct facial pock marks of which 20.8% had suffered smallpox between 1920 and 1930, 27.6% between 1930 and 1940, 17.2% between 1940 and 1950, 14.2% between 1950 and 1960, 5.7% between 1960 and 1970 and only 4.1% between 1970 and 1975. In 1974, 71 persons were recorded as having had smallpox. Thirteen persons with clear pock marks gave a history of a smallpox attack in 1975; they were found to be missing links in the chain of transmission in the investigated outbreaks.

Of those showing facial pock marks (3.1%) were pre-school children (four years old or less), 16.3% were of school age (5-14 years), 19.4% were young adults (15-24 years) and 61.2% were persons 25 years and older. There was a substantial disproportion between the sexes since more females were present at their homes during the teams' visits.

Out of the total of 59 214 persons seen and checked, 4758 (8%) were found to be without any vaccination scars. This group of unvaccinated persons consisted of about 2000 (3.4% of the total) who had suffered from smallpox in the past, a further 2100 (3.5%) children two years old or younger, and about 700 (1.2%) who escaped vaccination during the containment activities carried out in 1975.

Seven fever and rash deaths were discovered and reported which had occurred in the 20 months prior to the reinvestigation. A history of measles or chickenpox among other family members or in neighbouring households could be obtained in each case.

(iii) Remaining households in affected localities

The investigating team visited all remaining households in the affected villages or mohallas, interviewing and carrying out facial pock mark surveys among the village dwellers.

During these actions 68 626 additional houses were enumerated and visited and 114 441 household members seen and physically checked. Altogether 4597 persons having distinct facial pock marks were detected. The distribution of the year of their attack was found to be similar to those in the previous group. Only four persons were found with facial pock marks who gave a history of a smallpox attack since January 1975. Two of these were confirmed by an on-the-spot epidemiological investigation to have been smallpox patients.

(iv) Pock mark survey in the nearest localities

Finally, the investigating team carried out a pock mark survey in the three nearest villages having a common border with the affected one. Randomly selected households in each of the three villages were visited and a pock mark survey was carried out among pre-school children under five-years-of-age. Simultaneously, information about fever and rash cases/deaths was collected and diagnoses verified on-the-spot.

Altogether, 1017 villages, hamlets or mohallas were visited in this group and, from the total of 84 402 households, a sample of 42 459 was selected for the facial pock mark survey. A total of 51 357 children in the pre-school age-group were enumerated and 49 112 of them (96%) were seen and physically checked. From this total, 67 children (1.3 per 1000) were found with facial pock marks and from the total of 25 655 children in the age-group from three to four years, only 59 (2.3 per 1000) were found with facial pock marks. All of them were carefully interviewed about the nature of their skin changes and about any history of smallpox. It was found that none of them had suffered from smallpox since the beginning of 1975. From the total of 23 457 children who were two years old and younger only eight had suspicious facial skin changes. All of them were verified not to have been smallpox patients; a majority had a clear history of chickenpox.

(v) Surveillance containment activities in general

The number of smallpox cases which occurred in an outbreak represented one of the indices of the effectiveness of surveillance containment activities since rapid detection and immediate effective containment should result in small outbreaks. From an analysis of the outbreaks investigated it was found that 43.3% were "single" case outbreaks while 83.1% had less than five cases. Only 2.7% of the outbreaks had 20 or more cases and none had over 50 cases. In 65.7% of all outbreaks, infection was limited to one household only. Only in 3.4% of the outbreaks were 10 or more households affected.

The speed with which an outbreak was detected depended greatly on the effectiveness of surveillance activities: more than 51% of outbreaks were discovered in the first week after the date of onset of the first case, more than 20% in the second week, and about 90% in the first month leaving only 8% remaining undiscovered until the second month and only 2% later than that.

The rapidity with which smallpox outbreaks could be detected and subsequently reported to the level providing technical assistance for investigation and containment, played an important role in proper containment. In 78% of the cases the date of detection of outbreaks and the date of their being reported to the district level was the same. A delay in reporting of one week or more occurred less than 3% of the time.

Containment activities started on the same day foci were detected in about 60% of newly discovered outbreaks and more than three days after detection in less than 7%.

Of note is that 86% of outbreaks ended within one or two generations, 12% had three or four generations and only 2% developed five generations or more.

As already detailed, a total of 339 outbreaks, having active cases or still pending in the list of active outbreaks at the beginning of January 1975 were initially diagnosed as being caused by smallpox and were thus reported to the centre. Usually the results of laboratory tests were not known to the smallpox staff at the time when the outbreak was notified and containment started. During reinvestigation, an attempt has been made to confirm or correct the diagnosis on the basis of all available sources including laboratory tests. From the total of 339 outbreaks, a correction in diagnosis was made in 23 instances. On the basis of laboratory results, supported by field, clinical and epidemiological observations, the diagnoses were finally confirmed as follows:

Disease	Number	Percentage
Chickenpox	15	65.2
Syphilis	2	8.7
Suspected to be variola but laboratory negative	2	8.7
Drug-rash	1	4.3
Dermatitis	1	4.3
Pyrexia	1	4.3
Skin disease unclassified	1	4.3
Total	23	99.8

Routine notification and reporting is the framework of surveillance. During reinvestigation, an attempt was made to evaluate the completeness of notification and reporting of smallpox cases which had occurred in the investigated foci. It was found that from the total of 1166 smallpox cases recorded in 339 reinvestigated foci, 1146 had been notified and reported through official reporting channels during the initial investigation and containment done in 1975. An additional 20 persons, having pock marks and giving a history of a smallpox attack could be further detected through carefully carried out pock mark surveys and epidemiological interviewing done on an individual as well as household basis (Table 3).

TABLE 3. REINVESTIGATION OF SMALLPOX OUTBREAKS - INDIA 1976
20 UNDETECTED OR UNREPORTED SMALLPOX CASES FOUND

State	District	Locality	Age	Sex	Vaccination scar	Date of onset
Bihar	Bhojpur	Katoria	35	F	Yes	March 1975
			6	M	Yes	March 1975
	Katihar	Baltar	30	M	Yes	1975
			20	F	Yes	1975
			10	M	Yes	1975
			6	M	No	1975
			13	F	No	1975
			16	F	No	1975
			24	M	No	1975
			7	F	No	1975
	Nalanda	Nepura	10	M	Yes	1975
			5	M	Yes	Feb. 1975
	Ranchi	Honhe	2	F	Yes	March 1975
	Rohtas	Songawan	6	F	No	Dec. 1974
10			M	No	Nov. 1974	
4			M	No	Oct. 1974	
3			F	No	Dec. 1974	
Meghalaya	Garo Hills	Tura Bazar	3	F	No	Dec. 1974
Uttar Pradesh	Ghazipur	Sherpur	11	M	?	Jan. 1975
	Sitapur	Jainkinagar	1	M	Yes	Dec. 1974
			Mithaura	3	M	No

It is worth noting that five of these previously unreported cases were discovered among the members of households affected by smallpox, 13 among the dwellers in houses surrounding the affected ones and the remaining two cases in other parts of the affected locality. No unreported case related to the investigated outbreak was discovered in villages bordering the affected one.

In one State, during the checking of record keeping and reporting in the primary health centres and district health offices, seven smallpox outbreaks having active cases in 1975 were found not to have been reported to the State/Central levels (Table 4).

TABLE 4. REINVESTIGATION OF SMALLPOX OUTBREAKS - INDIA 1976
SMALLPOX OUTBREAKS FOUND TO BE UNREPORTED TO CENTRE

District	Affected locality		Number of		Date of	
	PHC	Village	Cases	Deaths	First case	Last case
Darbhanga	Bahari	Dainikhona	1	-	14. 1.75	14. 1.75
Monghyr	Shakpura	Akauna	25	2	17.11.74	26.12.74
Nalanda	Ishlampur Giriak	Ichahos	20	2	7. 8.74	4. 2.75
		Salenagar	1	-	10. 2.75	10. 2.75
		Dasarathpur	1	-	13. 2.75	13. 2.75
		Mustafapur	1	-	12. 2.75	12. 2.75
		Darbaspura	3	-	75	75

Last smallpox outbreak in State/UT if it occurred in 1974

Altogether 14 affected localities in 12 districts in 10 States and one Union Territory were visited by the investigating teams.

TABLE 5. SCOPE OF REINVESTIGATION ACTIVITIES - LAST
SMALLPOX FOCI IN STATE/UNION TERRITORY - 1974

State/Union Territory	Number of investigated				Smallpox		Household affected
	Dist.	Block	Localities	Outbreaks	Cases	Deaths	
Arunachal Pr.	1	1	1	1	1	1	1
Andhra Pr.	1	1	1	1	2	0	2
Haryana	1	1	1	1	3	1	3
Himachal Pr.	1	1	1	1	1	0	1
Jammu & Kashmir	1	1	1	1	1	0	1
Karnataka	1	3	3	3	6	1	3
Kerala	1	1	1	1	1	1	1
Maharashtra	1	1	1	1	1	1	1
Punjab	1	1	1	1	1	0	1
Rajasthan	1	1	1	1	26	5	14
Tamil Nadu	2	2	2	2	2	1	2
Total	12	14	14	14	45	11	30

Of the 30 households 29 were visited, one family having left the affected area and being untraceable. Of 278 persons enumerated only 178 were seen and interviewed; 37 persons among them were found to have distinct facial pock marks but no one in the age-group two years or younger. In one outbreak, in Vellore, North Arcot (Tamil Nadu) in addition to the known patients, three other persons were discovered with pock marks and a history of fever and rash attacks in March 1974 but who were not listed among the known smallpox patients. Furthermore, information was obtained about a fever and death which occurred in May 1974 in the same family and this is strongly suspected to have been caused by smallpox.

During the investigation 905 households surrounding the affected one were visited, 4973 residents enumerated of whom 2796 were actually seen and interviewed; 98 persons with pock marks were discovered but no history which might suggest that the outbreak investigated had continued beyond the last known date. No information was obtained about fever and rash deaths in the past two years.

Finally, 32 341 persons were enumerated in the remaining part of the affected locality and 28 992 of them were checked and interviewed. No sign of continued smallpox infection could be detected either among them or among the inhabitants in the three nearest localities (villages, hamlets, mohallas), having a common border with the affected one.

DISCUSSION

Field experience from countries recently endemic for smallpox has indicated that when hidden smallpox foci have persisted undetected for a long period of time, they have often lingered near old known outbreaks.

Therefore, all areas recently affected by smallpox transmission belong to the "high-risk" category of areas where "special searches" were planned and conducted. In addition to the regular active search operations carried out periodically all over India "special searches" of the 10 mile radius around each smallpox focus detected since January 1975 had been repeatedly carried out. All these vulnerable areas had been searched at least three times - at the beginning and end of containment activities and at the end of 1975. At that time, special attention was given to schools, markets, temples, places of pilgrimage, sites attracting migratory labour or areas having an administrative connexion with the place where smallpox had occurred since the beginning of 1975.

Reinvestigation of all smallpox foci detected since January 1975 had been planned and carried out as the last activity of the special searches in high risk areas in order to confirm and ensure that no unknown smallpox transmission existed in these vulnerable areas after the date of the last known case. It was also hoped to detect shortcomings in reporting and notification.

In spite of the extensive epidemiological investigations carried out in the affected localities as well as in those having a common border with them and interviews held in more than 128 000 households checking more than one-quarter of a million persons living in these vulnerable areas, no information about hidden smallpox foci could be collected and no unknown smallpox focus which might have occurred in 1975 was detected.

The high standard of both the initial epidemiological investigation and the containment activity in the vast majority of the reinvestigated outbreaks was confirmed. Through carefully conducted pock mark surveys combined with extensive interviewing, only 20 affected persons could be added to the 1146 smallpox cases already known and reported in the endemic areas. In non-endemic areas, only in North Arcot was there a strong suspicion that one reported outbreak continued longer than known in the same household but even here there were no secondary cases.

In 23 instances evidence was obtained that the infective agent was not variola virus. All these outbreaks were contained on the correct assumption that even a single case suspected to be smallpox must be taken as a public health emergency.

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FIG. 1. SMALLPOX OUTBREAK REINVESTIGATION
REINVESTIGATIONS CARRIED OUT IN THE DISTRICTS - INDIA, 1976

