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Epidemiological And Virological Studies On The Off-Season Smallpox Cases In Calcutta

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In Calcutta, although cases of smallpox can be found throughout the year, their number during the six months, June through November, is very small. Epidemiological and virological study of these off-season cases of 1967 and 1968 revealed that the majority of the 73 patients of the two years were residents of 'bustees' or slum areas, and 76 % of the cases had never been vaccinated. Clinical severity and mortality of the cases and the virulence of their causative virus strains as assessed by certain arbitrary laboratory tests were less than those found in the cases encountered during the smallpox season. History of five of the cases suggest that they might have contracted the infection outside Calcutta. In one instance, the infection was carried from Calcutta to a village in May, maintained there as man to man transfer till September when it was re-introduced in a different part of the city to initiate an outbreak.

Introduction

Smallpox breaks out in Calcutta almost regularly during the winter and early summer every year, and in some years in epidemic proportion. During the other months of the year, not much is heard of the disease although on enquiry at the Infectious Diseases Hospital (I.D.H.), Calcutta or with the health authorities of the city reports of sporadic cases can be obtained. A study of the admission records of I.D.H., which is the only centre in the city for isolation and treatment of smallpox cases, for the last five years (1962-1967) previous to the period of study shows that on an average, admissions during the period of six months, June-November, were much less than the same during the other six months (December-May) (Table I). The present work was undertaken to investigate the cases of the off-season months (June-November), as regards their incidence, clinical severity, epidemiological pattern, and the virulence of the causative virus strains, prevalent at that period. The period of study covered the calendar years of 1967 and 1968.

Material and Methods

Patients for study : I.D.H. was the main source of patients, although other sources of information about the cases like the Health Department of the Calcutta

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Table I. Monthly admission and death of smallpox cases during preceding five years, 1962-66 arranged according to six months of high incidence and six months of low incidence

	1962		1963		1964		1965		1966	
	Admission	Death	Admission	Death	Admission	Death	Admission	Death	Admission	Death
December	124	48	28	8	9	0	7	3	14	3
January	8	2	282	101	45	14	12	6	30	11
February	11	1	373	149	23	15	7	2	44	21
March	24	10	290	102	40	9	34	21	57	26
April	25	3	184	89	39	8	18	10	38	21
May	14	1	78	44	10	2	10	4	32	15
Total	206	65 (31·5%)	1235	493 (39·9%)	166	48 (28·8%)	88	46 (52·3%)	215	97 (45·1%)
June	4	3	30	10	3	2	3	1	21	4
July	11	4	27	7	8	1	10	3	18	6
August	7	6	12	9	2	0	0	0	5	2
September	3	1	8	4	6	0	2	2	2	1
October	3	2	4	0	2	0	0	0	1	0
November	25	8	17	4	1	0	2	0	1	0
Total	53	24 (45·3%)	98	34 (34·6%)	22	3 (13·6%)	17	6 (35·3%)	48	13 (27%)

corporation and private medical practitioners were also availed of. Localities, as per address of the patients admitted in I.D.H., were visited, and any other smallpox cases if found in the area were also examined. Epidemiological informations which might have bearing on the disease were collected from local medical practitioners and responsible persons of the area. In the latter process, particular emphasis was given to get information about the source of infection of the first case in the locality.

Vaccination status : Careful history of the disease and vaccination was obtained from the patients or their relations, and the presence or absence of vaccination scars were noted. As a proof of primary vaccination, presence of scar was more relied on than history, while about revaccination, more reliance had to be placed on answers to the leading questions put, specially if the patient or his relatives were found to be intelligent enough to know the difference between smallpox vaccination and any other injections.

Although there are several ways of classifying smallpox (Dixon 1962, WHO 1968), in the present work the patients were classified, for the sake of simplicity, into **haemorrhagic, discrete** and **confluent** as per criteria laid down by Sarkar and Mitra (1967). The **haemorrhagic** cases of the present series corresponded to the **fulminating** and **malignant confluent** cases of Dixon, the **confluent** cases to his **confluent** and **benign confluent** ; and the **discrete** cases to his **discrete, mild** and **abortive** cases.

Some of the cases of the present series could not be contacted, because (*i*) the cases were either cured or dead by the time information about them could be collected, or (*ii*) due to some practical difficulties it was not possible to visit them. Details of these patients were obtained from other people or patients who gave information about them. These cases have been marked in Tables I and II with asterisks.

All the patients admitted in the Smallpox Ward of the I.D.H. were investigated and only the virologically positive cases were included in the series. There were a few patients who were admitted in the Smallpox Ward on suspicion, but subsequently diagnosed to be otherwise, and they were excluded from the present series.

Isolation of the virus : Vesicular or pustular material from the cases was inoculated on the chorio-allontoic membrane (CAM) of embryonated eggs in the standard manner as was described previously (Sarkar **et al** 1959).

Virulence of the isolated virus strains : The laboratory tests as used by Sarkar and Mitra (1967) for assessing virulence of variola virus were employed in this work. The four parameters used were : (*a*) mortality of chick embryo after CAM inoculation of 10^6 pockforming units (PFU) of the virus strains, (*b*) mortality of infant mice after intraperitoneal inoculation of 3×10^5 PFU of the virus, (*c*) concentration of the virus in the liver of chick 72 h after CAM inoculation of 106 PFU of the virus and (*d*) histopathological study of the pock on the CAM.

Results

Tables II and III summarize the details of the cases encountered during the off-season months (June-November) of 1967 and 1968 respectively. The cases marked

with asterisks are those who could not be contacted, and information about whom was obtained from others. Under the column 'significant epidemiological information', the following points were specially stressed : (*i*) if the residence was in a **bustee** (congested slum) area, (*ii*) if he was a foot-path dweller or beggar, (*iii*) whether there was any chance of bringing the infection from a case outside Calcutta. The localities (in terms of postal zones) of Calcutta in which the cases resided and the serial number of patients (in the order of their admission into the hospital) have been shown in Maps 1 and 2. A few cases of I D.H. Calcutta (case Nos. 2 14 and 38 of 1967 and 2 and 5 of 1968) that came from outside the city have been shown outside Calcutta area in the maps and their locations are only approximate. Thirty nine of the cases were **confluent** and 34 were **discrete**. In one case (case No. 12 in Table II) there was history of bleeding from mouth but the exact fact about bleeding could not be ascertained and the case has been recorded as **confluent**. Table V shows the age and sex of these cases. There were 47 males and 26 females distributed in all age groups.

Table II Showing details of case of 1967

Serial number of cases	Date	Age in years, sex	Address, postal zone	Clinical type	Vaccination status	Significant epidemiological note if any	Result
1	June 1	12 M	29	D	P+R+	.	R
2	June 8	5 F	Tikkapara —Howrah	D	P—	From slum area or 'bustee' beggar	R
3	June 12	12 M	1	C	P—		R
4	June 26	12 F	2	D	P—	.	R
5	June 29	14 F	24	C	P–		Died
6	July 1	25 M	,,	D	P—		R
7	July 2	35 M	28	D	P —	..	R
8	July 3	30 M	6	D	P+R—	Footpath dweller	R
9	July 7	15 M	14	D	P+R+	.	R
10	July 11	28 M	28	D	P—	..	R
11*	July 2	26 M	,,	C	P—	First case in the locality	R
12*	July 8	20 M	,,	C(?H)	P—	Brother of case 10	Died
13	July 20	35 M	4	D	P –	..	R
14	July 28	22 M	Salkia, Howrah	D	P—	Footpath dweller, came from Nepal 3 months back	R
15	,,	7 F	4	C	P -	..	R
16	July 31	5 M	7	C	P—	Footpath dweller	R
17	,,	3 M	,,	C	P—	,,	R
18	,,	4 M	,,	D	P—	,,	R
19*	July 8	30 M	,,	C	P—	,,	Died
20*	July 10	52 M	,,	C	P--	,,	C
21*	July 14	4 M	,,	C	P—	,,	Died
22	,,	28 M	,,	C	P—	,,	Died
23	Aug 4	16 F	9	C	P+R—	Patient came from Gaya two weeks back when one member of her house was suffering from the disease	R

Table II (*Concld.*)

Serial number of cases	Date	Age in years, sex		Address, postal zone	Clinical type	Vaccination status	Significant epidemiological note, if any	Result
24	Aug 5	35	F	40	C	P—	From slum area or 'bustee'	R
25*	July 3	16	M	,,	D	P—	,,	R
26*	July 14	4	F	,,	D	P—	,,	R
27*	July 15	7	M	,,	D	P—	,,	R
28*	July 16	12	F	,,	C	P—	,,	Died
29*	July 22	22	M	40	C	P—	From slum area or 'bustee'	R
30*	July 28	32	M	,,	D	P—	,,	R
31*	Aug 2	40	F	,,	C	P—	,,	R
32	Sept 8	26	F	7	D	P+R—	Beggar	R
33	Sept 29	25	M	12	C	P—	Six days after coming from Darbhanga in the state of Bihar he got the disease	R
34	Oct 16	2½	F	28	C	P—	..	Died
35*	Oct 2	1	F	,,	C	P—	15 days after she came from Jazpur in the state of Orissa, she got the disease. First case in the locality	Died
36*	Oct 3	20	M	,,	D	P—	..	R
37*	Oct 11	26	M	,,	C	P—	Brother of case 36	R
38	Nov 11	70	F	Salkia, Howrah	D	P+R—	Fever started 4 days after she came from Sodpur (District of 24 parganas) where there was no case	

*Cases not visited and details obtained from other patients or their relatives

M = male ; F = female ; D = discrete ; C = confluent ; H = haemorrhagic ; P + or P— = primary vaccination taken or not ; R+ or R— = revaccinated or not ; R = recovered

Virus strains isolated from 20 confluent and 8 discrete cases were tested for virulence. Taking the arbitrary criteria of Sarkar and Mitra (1967) for calling a virus strain **virulent,** 4 out of 20 strains from **confluent** cases and none of 8 strains from **discrete** cases were found to be virulent.

Discussion

Areas of incidence : From Maps 1 and 2, it can be seen that the areas of incidence for the two years (1967 and 1968) are not the same. The pattern of incidence is also not similar. In 1967, although majority of the cases were from three localities quite a few came from scattered areas, whereas in 1968, the cases were restricted mostly in three localities. The areas of maximum incidence were **bustees** or slum areas where dwelling houses were closely adjacent with unsatisfactory sanitary

conditions, and each room in a house was occupied by a family of several members, thus providing chance for quick spread of infection.

There was no set pattern in the monthly incidence during the two years

Table III. Showing details of cases of 1968

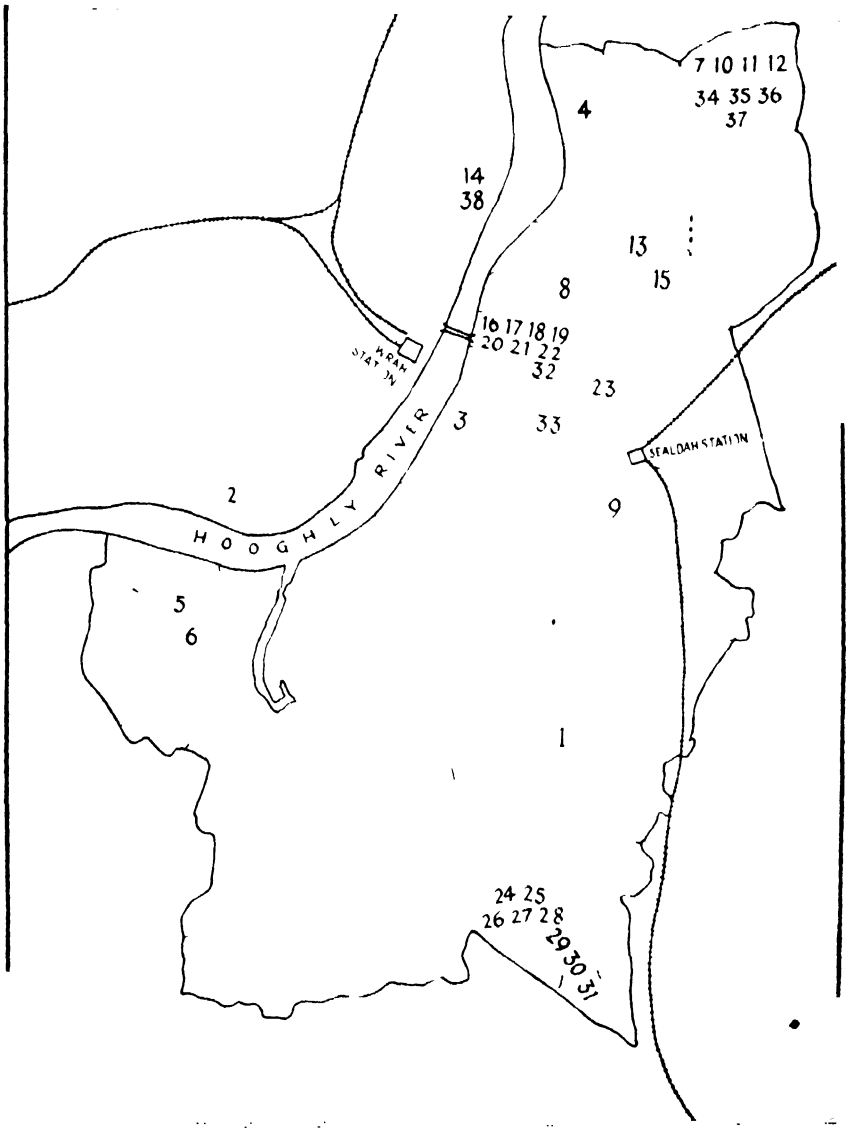
Serial No of cases	Date	Age in years, sex	Address postal zone	Clinical type	Vaccination status	Significant epidemiological note, if any	Result
1	June 5	16 M	14	C	P—	Beggar	Died
2	June 6	42 M	Borla-Howrah	C	P—		Died
3	June 23	52 M	38	D	P+R+		R
4	June 23	26 F	38	D	P+R+	Belongs to family of case 3	R
5	June 24	25 F	Bishnupur 24 Parganas	D	P+R+	Cases belonging to the same family Case No 9	
6	July 24	52 M	8	D	P+R+	is the first case in the	R
7	July 13	6 F	8	D	P —	locality who contracted	
8	July 13	9 M	8	C	P —	the disease at Uluberia	
9	July 13	44 F	8	C	P+R+	in Howrah district	
10*	July 12	20 M	8	D	P—		R
11*	July 16	52 F	8	C	P—		R
12*	July 27	8 M	8	D	P —		R
13*	July 27	26 M	8	D	P—		R
14	Sept 18	35 F	4	D	P+R+	From slum area or 'bustee'	R
15	Sept 18	4 M	4	C	P+R—	Son of case 14	R
16	Sept 18	7 M	4	C	P-	Son of case 14	Died
17	Sept 19	11 M	4	C	P—	Same house as case 14	R
18	Sept 21	30 M	4	D	P+R—	Next door neighbour of case 14	R
19*	Sept 12	10 M	4	C	P—	First case in the locality Came from Shibganja village in Howrah District	R
20*	Sept 14	1½ F	4	C	P—	Next room neighbour of case 14	Died
21*	Sept 14	5 F	4	D	P—	,,	R
22*	Sept 18	3 F	4	C	P—	,,	Died
23	Sept 28	25 M	40	C	P+R—	Used to visit house of case 14	Died
24	Oct 1	30 F	4	C	P+R —	Neighbour of case 14	Died
25	Oct 2	4 F	6	C	P		Died
26	Oct 2	3/12 M	14	C	P		Died
27	Oct 7	35 M	4	D	P—		R
28	Oct 10	7 M	4	C	P—		R
29	Nov 2	12 M	23	D	P—	From slum area or 'bustee'	R
30	Nov 6	2½ M	4	C	P —		Died
31*	Nov 2	14 M	23	C	P—	From slum area or 'bustee'	R
32*	Nov 2	18 M	23	D	P—		R
33*	Nov 3	38 M	23	D	P—		R
34*	Nov 5	20 M	23	D	P+R—		R
35	Nov 7	7 F	23	C	P—	..	Died

*Cases who were not visited and details about whom were obtained from other patients or their relatives

M = male, F = female, D = 'discrete', C = 'confluent', H = 'haemorrhagic', P+ or P— = primary vaccination taken or not, R+ or R— = revaccinated or not, R = recovered

Map 1

Map of Calcutta showing distribution of cases and their serial order in 1967



The numbers indicate serial number of the cases

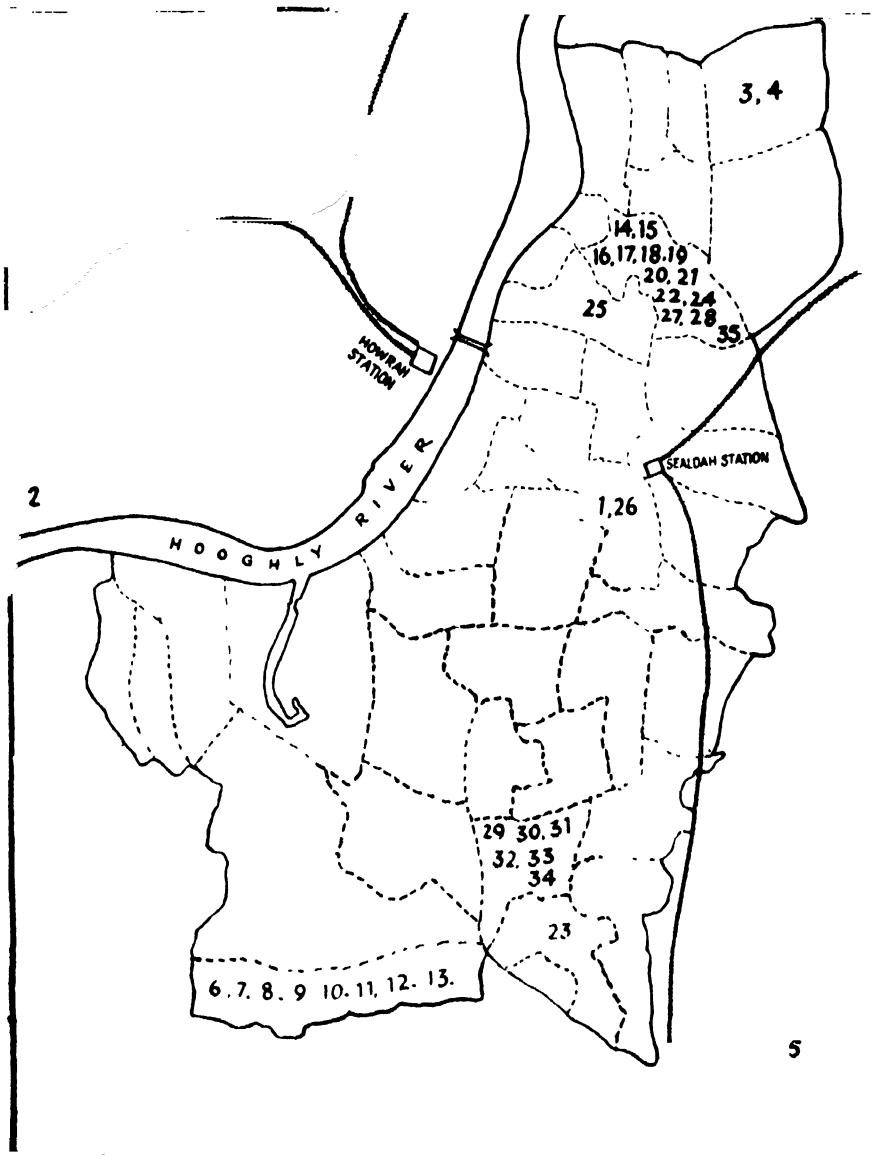
Socio-economic status of the patients : On visiting the families it was found that almost all the patients belonged to the low socio-economic group Twelve of the 73 patients of the two years were beggars or footpath dwellers whose profession compelled them

to be migratory. Many of the rest were also manual labourers or craftsmen, who did not work in fixed places.

Vaccination status : Out of 73 patients, 56 (76·7%) were never vaccinated. 8 (10·0%) had both primary and revaccination, while 9 (12·4%) had only primary vaccination

Map 2

Map of Calcutta showing distribution of cases and their serial order in 1968



The numbers indicate serial number of the cases

during infancy or childhood. From the old records it was found that out of 80 cases of a previous period of six months of smallpox season (December-May), 40 (50%) were never vaccinated, 16 (20%) had both primary and re-vaccination, while 24 (30%) had only taken primary vaccination. Thus the proportion of unvaccinated cases happened to be higher during the off season months under study.

Table IV. Distribution of age and sex of the off-season cases of 1967 and 1968

Age in years	1967			1968		
	Male	Female	Total	Male	Female	Total
0—9	5	5	10	8	6	14
10—19	4	4	8	5	1	6
20—29	9	1	10	4	2	6
30—39	6	1	7	3	2	5
40 and above	1	2	3	2	2	4
Total ..	25	13	38	22	13	35

Clinical severity of cases and virulence of causative virus : There was no haemorrhagic case, except case No.12 of 1967 who is said to have had some bleeding from his mouth. 53·4% of the cases were **confluent** and 46·6% were discrete. In comparison to these, in the 80 cases during the smallpox season as mentioned above, there were 7 (8·7%) haemorrhagic, 48 (60%) confluent and 25 (31·3%) discrete cases. Nineteen of the 73 cases of the present series died and all of them were unvaccinated. Of the 34 discrete cases, 67·6% had never been vaccinated, and another 15% took only primary vaccination, while 84·6% of the 39 confluent cases were unvaccinated. Mild clinical picture (discrete) in so many unvaccinated cases is noteworthy. From Table I, it can be seen that overall mortality during the off-season period of the five years was less than that of the smallpox seasons. A closer scrutiny of Table I reveals two interesting facts: (*a*) although 1963 was an unusually severe epidemic year (the number of cases being very high) out of the five years, mortality was not the highest ; (*b*) during the off-season six months of 1962 just preceding the epidemic of 1963 (which really started in December 1962), mortality figures were quite high, and that is why the percentage of mortality (45°3%) during the off-season months of 1962 was higher than that (31·5%) of the smallpox season. Whether the virus strain gained virulence while in circulation during the off-season months of 1962, or a new virulent strain was introduced in the community during this period to cause an epidemic in 1963, or the findings were just incidental, is a matter for speculation.

Out of 20 strains of virus (isolated from confluent cases of the present series) and 8 strains (isolated from discrete cases) that were tested for virulence in the laboratory, 20% of the strains from confluent cases and none from the strains from discrete cases were found **virulent** as per the criteria stated previously. These figures are less than those (36% of strains from confluent and none of the strains from discrete cases)

of Sarkar and Mitra (1967) whose strains were all collected from cases occurring in the smallpox season. This is also consistent with the finding of low incidence of cases, lower mortality in comparison to the overall mortality of the seasonal cases of the previous five years, absence of haemorrhagic cases and lower proportion of confluent cases during the off-season months. This does not rule out factors, other than virulence of the causative virus, to be responsible for this different picture of smallpox during the off-season period. It may be mentioned here that none of the strains in the present series proved to be variola minor on testing by growing them at 38·5°C (Nizamuddin and Dumbell 1961).

Origin and spread of cases : Up till now, no animal has been incriminated to be the reservoir of smallpox virus, and man to man infection is considered to be the only method of spread. In the three cases (case Nos. 23, 33 and 35) in 1967, and two cases (case Nos. 9 and 19) in 1968, the case histories suggested that the infection might have been introduced in the city of Calcutta from areas outside the city. The widely separated areas of occurrence of some of the consecutive cases may not be unusual if we consider the potentiality of the beggars, footpath dwellers and bustee dwellers (who usually worked as manual workers in different parts of the city) to spread infection to different parts of the city. Most of the cases of 1967 and 1968 can be grouped into six outbreaks in bustees where spread occurred mainly due to close contact of the inhabitants. Case No. 23 of 1968, although living at a distance from the postal zone 8 (where many cases occurred) was found to be a frequent visitor to the house of case No. 14 when she was ill. Thus, he seems to have contracted the disease from case No. 14. On investigating case No. 14, original source of infection in the locality was traced to be case No. 19 (the first case in the area), whose family moved away from a village (Shibganja) in the Howrah district (about 30 miles from Calcutta) where several cases had occurred. On enquiry at the village Shibganja, it was revealed that cases had been occurring there in chain since preceding May, when the first case of smallpox came to the village from the port area of Calcutta city. Thus, it seems that the infection was introduced into the village from Calcutta in May 1968, maintained there as man-to-man infection till September 1968 when it was re-introduced into another part of Calcutta to initiate a small outbreak during the off-season months.

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References

Dixon C.W. 1962. Smallpox, 6-7. J & A Churchill Ltd., London.

Nizamuddin, Mohammed and Dumbell, K.R. 1961. A simple laboratory test to distinguish the virus of smallpox from that of alastrim. **Lancet I**, 68-69.

Sarkar, J.K. and Mitra, A.C. 1967. Virulence of variola virus isolated from cases of varying severity. **Indian J Med Res 55,** 13-20.

Sarkar, J.K. Neogy, K.N. Chowdhuri, H.P. and Lahiri, D.C. 1959. Studies on the techniques applicable for characterisation of variola virus. **J Indian Med Ass 32,** 429-431.

WHO 1968. Smallpox Eradication, WHO Technical Report Series No. 393.