

# The eradication of smallpox in Shanghai, China, October 1950 – July 1951

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*Smallpox (variola major) was endemic in China for thousands of years until it was finally eradicated from the country in the early 1960s. The strategy and tactics of the eradication campaign in Shanghai, the largest city and major communications centre in China, were typical of those employed throughout China, but had some additional features of interest.*

*The decision to eradicate smallpox was made in 1950 and three preparatory steps were taken immediately: supplies of potent (liquid) vaccine were assured; popular support was enlisted by intensive propaganda; and teams of vaccinators were trained. In Shanghai, the mass vaccination campaign began in October 1950, at a time when a smallpox epidemic was raging in the city. The last case of smallpox in the city was recorded in July 1951. A special feature of the campaign in Shanghai was the introduction of a national vaccination certificate to prevent export of smallpox from the city by the 2 800 000 persons who moved in and out of Shanghai each week by rail, bus, or boat.*

*Eradication was followed up by a programme of vaccination of all infants, with revaccination at 6, 12, and 18 years of age, and mass vaccination campaigns in 1963, 1968, 1972, and 1978. The number of adverse reactions to vaccination was small and fell progressively from an overall figure of 8.4 per 100 000 in 1963 to 2.5 per 100 000 in 1978. Vaccination requirements were relaxed in 1978, but smallpox vaccination is still offered to children as part of the immunization programme.*

Smallpox (*variola major*) was introduced into China from the south-west in the first century A.D., and was endemic from that time until it was eradicated from the country in the early 1960s. Variolation had been practised in China since the Sung dynasty (1023 – 55), and vaccination was started on a limited scale in 1803, but until 1951 the disease continued to cause much illness and death. Immediately after the establishment of the People's Republic in 1949, vaccine production facilities were set up to cover the whole country, and in October 1950 the government announced its goal of eradicating smallpox by vaccination of the whole population. The present report describes the eradication of smallpox in Shanghai, the largest city and major communications centre of China.

## THE MUNICIPALITY OF SHANGHAI

Shanghai, one of the three centrally administered cities of China, consists of 10 counties and 10 urban districts, with a total area of 6185 km<sup>2</sup> and a current population (1980) of just over 11 million. It has long been the main port of China and was a major centre of conflict in the war against Japan and in the subsequent struggle against the Kuomintang between 1945 and 1949. When it was finally liberated in May 1949, its pre-war population of 1.2 million had grown to 5.4 million, largely because of the influx of refugees from surrounding districts. At the time of the smallpox eradication campaign, which took place from October 1950 to July 1951, the Shanghai municipality comprised 20 urban and 9 suburban districts.

Although international shipping was restricted in the years immediately after 1949, there was a great deal of internal coastal and river boat movement through the port of Shanghai. In addition, the city had major rail and road links with other parts of the

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country, centred on one railway station and a few long distance bus stations for the Shanghai – Nanjing and Shanghai – Hangchow highways. At the time of the eradication campaign, approximately 2 800 000 travellers entered or left Shanghai each week.

#### THE SMALLPOX ERADICATION PROGRAMME

##### Background

As in other endemic areas, both mortality and morbidity from smallpox were grossly underreported, especially during the Japanese occupation of the city between 1942 and 1945. Nevertheless, the figures available for the period 1930–51 indicate that, although the disease was always present, there were epidemic episodes during the periods 1930–34, 1936–39, 1946–48, and in 1950 when the eradication campaign began.

Smallpox was mainly a disease of childhood, with mortality rates highest in children less than five years old. There was a marked seasonal variation in the number of cases of smallpox, with a high incidence in winter and spring (December – May) and a low incidence in summer and autumn (August – November).

During the period prior to the war with the Japanese, both vaccination and variolation were practised in Shanghai (1), but both were expensive and few of the poorer people were inoculated. Variolation was banned long before 1949 and, until 1951, overall vaccination rates were low (Table 1).

The decision to eradicate smallpox in China was promulgated in October 1950 by the state council of the central government, in a "Notice on the Campaigns for Smallpox Vaccination of Autumn 1950". The vaccination campaign itself was preceded by a massive propaganda campaign to enlist the support of the whole population, and the training of large numbers of vaccination teams.

Table 1. Smallpox vaccination rates in Shanghai, 1946–51

Year	Population	No. of persons vaccinated	Vaccination rate (%)
1946	3 536 209	536 573	15.2
1947	3 925 621	2 251 096	57.3
1948	5 204 321	2 464 381	47.4
1949	5 406 644	1 447 609	26.8
1950	5 063 818	2 232 340	44.1
1951	5 333 036	6 925 363 <sup>a</sup>	129.9 <sup>a</sup>

<sup>a</sup> Includes visitors, travellers, and persons vaccinated more than once.

##### The mass vaccination campaign of 1951

Throughout China, the Temple of Heaven strain of vaccinia, prepared in calves and glycerinated, was used as a liquid vaccine. Smallpox vaccination was free and compulsory for all except those with contra-indications.

The aim of the campaign in Shanghai was to vaccinate 95% of the population in the shortest possible time. In order to accomplish this, 6944 medical and paramedical personnel were organized into 1319 permanent stations and 1836 mobile vaccination teams. The personnel, comprising 3173 traditional Chinese medical doctors, 2067 doctors of western medicine, 455 nurses and midwives, 1126 medical students, and 123 others, were given a short training in order to standardize the vaccination technique.

The mass vaccination campaign began in March 1951, when an epidemic of smallpox was raging in Shanghai. As the number of vaccinations rose, the incidence of smallpox fell (Table 2), and the last case in Shanghai was reported on 26 July 1951.

Table 2. The cumulative vaccination rate and the incidence of smallpox in Shanghai in 1951

Month	Cumulative vaccination rate (%)	No. of reported smallpox cases
January	11.5	958
February	19.1	646
March	88.1	722
April	108.0	325
May	110.3	55
June	110.4	18
July	110.5	10
August	110.6	0

An important feature of the Shanghai campaign was the need to prevent the movement of persons suffering from smallpox into or out of the city. Special measures were adopted by the Health Bureau of the Shanghai Railway Offices and by the Quarantine Service of Shanghai Harbour to deal with all travellers and with boat dwellers on the Huangpu River. All travellers had to show a certificate of vaccination or be vaccinated before they were allowed to board a boat, train, or long-distance bus. Ships' crews were mobilized as "health groups", and between January and July 1951, 35 smallpox cases were recognized among 355 986 boat passengers.

Thus, in spite of the severe epidemic of smallpox in Shanghai in 1951, there were no outbreaks elsewhere in China originating from cases in Shanghai.

Table 3. Smallpox vaccination rates during mass vaccination campaigns in Shanghai

Year	Population	No. of persons in whom vaccination was indicated (age 1 – 55 years)	No. of persons vaccinated	Vaccination rate (%)	
				for whole population	for those indicated
1963	10 647 000	6 217 987	5 173 365	48.6	83.2
1972	10 665 050	8 991 802	7 580 089	71.1	84.3
1978	10 923 759	8 458 607	6 376 908	58.4	75.4

### Follow-up measures

Various follow-up measures were applied in order to prevent the reappearance of smallpox. Beginning early in 1953, compulsory vaccination against smallpox was given to all infants at age two months, with revaccination at 6, 12, and 18 years of age. In addition, over the last 30 years, mass smallpox vaccination campaigns have been organized every 4–6 years, and were carried out in Shanghai in the years 1963, 1968, 1972, and 1978 (Table 3). Because of the global eradication of smallpox, the vaccination regulations were changed late in 1978. Primary vaccination is still required for one-year-old children, but further vaccination at 6 and 18 years of age is no longer compulsory.<sup>a</sup> Vaccinators were specially trained for each of the mass vaccination campaigns, and the take rates and vaccination reactions were examined regularly in groups of vaccinees of different ages and occupations. Vaccination reactions were examined on the third and the seventh days (Table 4).

Over one quarter of those tested in 1951 gave a primary reaction, but the level fell substantially in

subsequent years because of the high vaccination rate that had been established. In 1963 and 1978, there was no take in very few unvaccinated individuals (0.1% and 0.2%) and in a slightly higher proportion of those previously vaccinated (2.3% and 1.4%) (Table 5). About 30% of those previously vaccinated had an immediate reaction.

Surveillance for possible cases of smallpox was maintained through a system of reporting notifiable diseases including smallpox, chickenpox, and measles. All cases of suspected smallpox, of which there were about five each year in Shanghai between 1951 and 1966, were subjected to intensive epidemiological and virological investigation, but none of these was confirmed after 1951.

### Adverse reactions to vaccination

Few adverse reactions were noted, in agreement with results from other areas (2). Table 6 sets out the adverse reactions observed during the mass vaccination campaigns carried out in 1963, 1972, and 1978. Post-vaccinial encephalitis was extremely rare, there being only 5 cases in nearly 18 million vaccinations.

The complications observed after primary and follow-up vaccination were recorded for 1978, but not for other years. All complications except purpura

<sup>a</sup> In August 1981, China officially informed WHO that routine smallpox vaccination was no longer obligatory. However, vaccination will be ended completely only after widespread health education activities.

Table 4. Vaccination reactions determined on selected samples of the population

Year	No. of persons examined	Successful vaccination <sup>a</sup>				No take	
		No.	%	Primary reaction	%	No.	%
1951	312 319	293 536	94.0	79 690	25.5	18 783	6.0
1955	4 797	4 647	96.9	298	6.3	150	3.1
1959	13 688	12 464	91.1	851	6.2	1 224	8.9
1963	13 863	13 526	97.6	572	4.1	337	2.4
1972	9 822	9 723	99.0	310	3.2	99	1.0
1978	16 911	16 629	98.3	1 022	6.2	282	1.7

<sup>a</sup> Includes primary, accelerated, and immediate reactions.

Table 5. Reactions after primary and follow-up vaccination, 1963 and 1978

Year	No. of persons examined		Primary or accelerated reaction		Immediate reaction		No take	
			No.	%	No.	%	No.	%
1963	13 863	Primary vaccination	119	0.9	0	—	20	0.1
		Revaccination	9 126	65.8	4281	30.9	317	2.3
1978	16 911	Primary vaccination	217	1.3	0	—	37	0.2
		Revaccination	11 416	67.5	4996	29.5	245	1.4

were much more common after primary vaccination, the overall rates being 39.84 and 2.11 per 100 000 primary and follow-up vaccinations respectively.

#### DISCUSSION

Smallpox was eliminated in most formerly endemic countries by mass vaccination followed by surveillance and containment, the last being regarded as the most important component (3). This report indicates that mass vaccination was successful in eliminating smallpox from Shanghai. Elsewhere in China, surveillance and containment were important only in the border regions of Yunnan and Tibet; for the country as a whole, mass vaccination, using liquid vaccine,

was sufficiently intensive and effective to break the chains of transmission. Subsequently the immune status of the population was maintained by regular primary vaccination of newborn children, with revaccinations at 6, 12, and 18 years, allied with periodical mass vaccination campaigns covering the entire population. During recent years, the requirement for vaccination has been considerably relaxed, and exemption has been given on the grounds of eczema, intercurrent infection, etc. However, mothers still request vaccination of newborn children and this is provided, even though there is now no risk of smallpox infection.

A novel feature of the campaign in Shanghai was the need to prevent spread of the disease from this major communication centre to other parts of the country, which was achieved by requiring vaccination certificates for all travellers moving outside the city.

Table 6. Complications of smallpox vaccination

Diagnosis	1978											
	1963		1972		Primary vaccination		Revaccination		Total		Total	
	No.	Rate per 100 000	No.	Rate per 100 000	No.	Rate per 100 000	No.	Rate per 100 000	No.	Rate per 100 000	No.	Rate per 100 000
Postvaccinial encephalitis	3	0.08	2	0.03	0	0	0	0	0	0	5	0.03
Vaccinia necrosum	7	0.18	2	0.03	0	0	0	0	0	0	9	0.05
Eczema vaccinatum	2	0.05	7	0.10	4	4.31	2	0.03	6	0.09	15	0.08
Generalized vaccinia	17	0.43	12	0.17	1	1.08	0	0	1	0.01	30	0.17
Vaccinia multiforme <sup>a</sup>	243	6.19	91	1.29	15	16.15	88	1.36	103	1.57	437	2.45
Vesicular multiforme rash <sup>b</sup>	No data		48	0.68	5	5.30	2	0.03	7	0.11	55	0.40
Purpura	3	0.08	8	0.11	0	0	3	0.05	3	0.05	14	0.08
Accidental infection	54	1.38	73	1.04	12	12.92	41	0.63	53	0.81	178	1.00
<b>Total</b>	<b>329</b>	<b>8.41</b>	<b>243</b>	<b>3.44</b>	<b>37</b>	<b>39.84</b>	<b>136</b>	<b>2.11</b>	<b>173</b>	<b>2.52</b>	<b>743</b>	<b>4.17</b>

<sup>a</sup> Mild generalized vaccinia.

<sup>b</sup> Mild generalized vaccinia with vesicular rash.

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## RÉSUMÉ

## ÉRADICATION DE LA VARIOLE À SHANGHAI, CHINE, OCTOBRE 1950 – JUILLET 1951

La variole a été endémique en Chine pendant des millénaires jusqu'à ce qu'elle soit finalement éradiquée dans l'ensemble du pays au début des années 1960. Le présent rapport décrit la stratégie et la tactique de la campagne d'éradication qui a été menée à Shanghai, la plus grande ville et le principal centre de communications de la Chine.

C'est en 1950 qu'il a été décidé d'éradiquer la variole et trois mesures préparatoires ont été immédiatement prises: des approvisionnements en vaccin actif (liquide) ont été assurés, le soutien populaire a été obtenu par une propagande intensive et des équipes de vaccinateurs ont été formées. A Shanghai, la campagne de vaccination de masse a commencé en octobre 1950, à un moment où une épidémie de variole faisait rage dans la ville. Le dernier cas de variole a été enregistré en juillet 1951.

La vaccination a été effectuée par un total de 6944 vaccinateurs, organisés en 1319 équipes fixes et 1836 équipes mobiles. Au cours de l'année 1951, 6 925 363 personnes ont été vaccinées, chiffre qui dépassait celui de la population de la ville à ce moment parce qu'il comprenait de nombreux voyageurs. Un caractère particulier de la campagne réalisée à Shanghai a été l'élaboration d'une procédure de «certificat national de vaccination» destinée à empêcher que la variole

ne soit exportée par les 2 800 000 personnes qui pénétraient à Shanghai ou en sortaient chaque semaine par le rail, la route ou l'eau. Trente-cinq cas de variole ont été diagnostiqués durant la première moitié de 1951 parmi les 356 986 personnes qui ont voyagé par bateau au cours de cette année.

Il y a eu environ cinq cas suspects de variole par an pendant les quelques années qui ont suivi la vaccination. Chacun a été soumis à un examen épidémiologique et virologique approfondi et tous se sont révélés négatifs.

L'éradication a été suivie par un programme assurant la vaccination de tous les nourrissons, la revaccination des enfants aux âges de 6, 12 et 18 ans et des campagnes de vaccination de masse en 1963, 1968, 1972 et 1978. Le nombre de réactions adverses à la vaccination a été faible et en général s'est abaissé progressivement d'un taux global de 8,4 pour 100 000 en 1963 à 2,5 pour 100 000 en 1978. Les réactions vaccinales étaient beaucoup plus fréquentes après la vaccination primaire (40,91 pour 100 000) qu'après revaccination (2,18 pour 100 000). Les exigences relatives à la vaccination ont été encore assouplies vers la fin de 1978, mais la vaccination antivariolique reste encore offerte aux enfants dans le cadre du programme de vaccination.

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