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SMALLPOX CONTROL IN INDONESIA DURING THE SECOND QUARTER OF THE
CENTURY AND RE-ESTABLISHMENT OF ENDEMIC SMALLPOX FROM 1947

by

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1. INTRODUCTION

In the present drive for global smallpox eradication, the results achieved in former days are acknowledged but seldom analysed. Truly, the conditions allowing successful smallpox control in the countries of Europe and North America do not seem relevant to the problems of our days in many endemic areas. This objection, however, is of little import with regard to the results obtained by systematic vaccination around 1930 in the Netherlands East Indies. The meeting of a Scientific Group on Smallpox Eradication, convened by the World Health Organization in October 1967, gave cause to reconsideration of a smallpox control effort that was brought to success in a vast, in some areas desensely populated, archipelago.

The Indonesian archipelago of 2000 islands is situated at both sides of the equator between the South-East Asian continent and Australia. As a political entity a vast part of its territories is presently known as the Republic of Indonesia but during the period covered by the main parts of this report, as the Netherlands East Indies. The name of Indonesia as used in this paper indicates the territories of both political entities also during an intervening period (1942-1949) of Japanese occupation and of political and military conflicts.

The dimensions of the global area covered by Indonesia is 5000 kilometres in East-West direction and 2000 kilometres in North-South direction. As is shown by Table I the population density varies to a large extent. This situation has its impact on smallpox endemicity and on the problems of smallpox control. Traditionally, inter-insular traffic was provided for by ships but in more recent years communication by air has come to the fore.

Before 1942 a distinction is often made for administrative purposes between Java (inclusive the adjacent island of Madura) and the so-called Outer Provinces. The island of Java, seat of the central government and inhabited by about two-thirds of the population was clearly more accessible for administrative activities like the Public Health Service than more remote areas with relatively small numbers of inhabitants. It is therefore of some use to follow this distinction also with respect to the problems of smallpox endemicity and smallpox control, which both are markedly influenced by population density and transport facilities.

2. SHORT REVIEW OF SMALLPOX CONTROL IN INDONESIA UNTIL 1920^{1,2}

Vaccinia virus was brought to Java in 1804 by means of children vaccinated en route between Mauritius and Java. The use of human lymph in a strict organization, insuring the preservation of virulent virus - at least in Java - dates from 1856.

A central lymph institute was opened in 1891 and in the following decades animal lymph, prepared on the skin of buffaloes, gradually replaced human lymph. The use of human lymph was first abolished in Java (1909) and later on also in the Outer Provinces (1918).

All animal vaccine used in the archipelago was produced in the Government Lymph Institute at Batavia (Djakarta), later on at Bandung. About 60 buffaloes, each yielding about 300 grams of crude pulp, sufficed to supply all parts of Indonesia with fluid vaccine for one year. Transport by ship to remote islands, often followed by road transport to interior parts could be a matter of several weeks and even months. These circumstances posed of course problems of vaccine potency.

Occasional low virulence of lymph was only one aspect of the difficulties which opposed a proper control of smallpox during the 19th and the early decades of the 20th century. A second problem was to cover a sufficient proportion of the population for primary vaccination and for revaccination in each vaccination district.

The organized vaccination programme which had its start in Java (1856) was based on about 200 vaccination districts, each served by an Indonesian vaccinator. Each district had to be covered by the vaccinator once in three months' time, four times a year. A district was divided up into 13 sectors, one sector for each week of the three months' period. The vaccinator visited three or four collecting points in the sector, starting on Monday near the centre of his district and travelling on Tuesday and Wednesday (and Thursday) to collecting points in peripheral direction of his district. As the next week's sector bordered on the former one, mothers could be ordered to report with their recently vaccinated babies to the collecting point in the adjacent area, thus providing the opportunity to collect human lymph for inoculations in the next week's sector. This so-called circle system was originally set up to insure the preservation of human lymph, but it was continued after the introduction of animal lymph.

Assuming an annual birth rate of 4%, the vaccinator was expected to inoculate three to six months old babies to an amount of 1% of the population, at each quarterly visited collecting point. He had, moreover, to perform revaccinations on 2-1/2% of the older population, making 10% per year so that revaccination of the whole population could be completed in each 10-year period.

Although, in theory, this system provided for early primary vaccination and regular revaccination, its effects were less satisfactory than was hoped for. Assuming even that the number of vaccinations by a proper technique and with potent vaccine was sufficient, there was no guarantee at all that the imperative number of primary vaccinations were not attained by including revaccinations, neither that revaccination covered each time another 2-1/2% of the population.

Smallpox indeed continued to be a large problem in Indonesia and attained sometimes epidemic characteristics. According to Terburgh³ more than 18 000 cases with more than 5000 deaths occurred in Eastern Java's 10 500 000 inhabitants, during 1913.

About 1920 a number of changes were made, which were followed by a marked decrease and eventually led to an all but complete disappearance of smallpox in the later thirties.

3. SMALLPOX CONTROL IN INDONESIA FROM ABOUT 1920 UNTIL WORLD WAR II^{1,2,4,5}

The decline of smallpox from 1921 until 1940 is illustrated by the figures of Table II. This favourable course was coincident with and may be attributed to developments which all pertained to a more complete and more effective coverage of the population by vaccination, viz.

- (a) Establishment of a separate Civil Public Health Service (apart from the Military Medical Service) in 1910, which provided, after a number of years, a sufficient number of supervizing regional physicians, engaged full-time in public health work, at least in the more populous areas.
- (b) Production of a stable dried vaccine by Otten, specially meant for distribution to remote areas.
- (c) The system of concurrent primary vaccination and revaccination was replaced, in Java first, by a dual system by which sessions for quarterly primary vaccination of 3-6 months old children, and those for revaccination of the older population in five to 10 year rounds, were separated.

The dual system of separate tours of the vaccinator for primary vaccination and for revaccination was first introduced by Terburgh³ in Eastern Java. The former vaccination districts (as a rule of 100 000 - 350 000 inhabitants) each served by a trained vaccinator - four months training courses were given at the Government Lymph Institute - were not changed for this new policy.⁵ The essential alteration was, that the vaccinator spent only about

eight weeks of each three months period for primary vaccination of infants. In order to make a complete tour of his district the number of weekly vaccination days had to be increased from three to four to four to five and the number of collecting points was reduced in some degree. The official regulations⁵ allowed 4.5-6 kilometres as largest distance to the collecting points which mothers with their young babies had to travel. The maximal number of babies to be vaccinated at a point was recommended as 150. Assuming a birth-rate of 4% and quarterly visits, a collecting point could serve a maximal population of about 15 000.

The remaining five weeks of each three months period was fully spent performing revaccination. Revaccination, under the new policy, was directed to provide as complete as possible coverage of the population (at least 80%). This systematic revaccination, village by village according to a strict scheme, could be completed in five to 10 years' time. According to the regulations, no more than 500 people should be summoned daily for revaccination. In densely populated areas, this meant that the vaccinator stayed for more than one day at a collecting point.

It seems hardly necessary to add that the actual schemes of the vaccinator's tour and his activities were to a large extent influenced by local circumstances, certainly in the Outer Provinces. The vaccinator, however, had to work according to a plan designed or approved by the regional medical officer who knew exactly where he could expect a certain vaccinator to be travelling or inoculating. His work could readily be checked by unannounced visits.

Results of primary vaccination were checked at the next quarterly visit to the collecting point, so that up to 300 mothers with their children were gathered at a session; up to 150 for primary vaccination as well as for reading of the success rate obtained by the foregoing visit. Inoculation was performed with 2 cm linear scratches. A total scar length of at least 2 cm was considered as a successful take.

Supervision of the vaccination service at regional level was done by the district medical officer. Apart from administrative checks, he visited without prior notice the vaccination sessions; he could visit children in their homes or in school to look for scars; and, by an early visit after completion of the revaccination, he was able to see what proportion of the population had in fact been subjected to revaccination.

It was of major importance for the vaccinator's activities, that furthering of smallpox vaccination was one of the expressly formulated duties of civil administration servants of all ranks.

In the period of 1933 to 1938, the annual number of primary vaccinations amounted to 1 850 000 and the number of revaccinations to 5 700 000 (Table III). In 1937 the population was estimated to be about 65 000 000. So, each year more than 10% of the population was inoculated. As the dual system of completely separate primary vaccination and revaccination prevented to a very large extent the evil of frequent revaccination, again and again, of only a limited part of the population, the figures of Table III, taken at their face value, give confidence as to the general immune status to smallpox.

These results were obtained in 425 vaccination districts;⁸ 175 districts in Java (adjacent islands of Madura, Bali and Lombok included) with a population of about 43.5 millions and 250 districts in the Outer Provinces with about 17 000 000 population. Lacunae in the actual execution of the programme were undoubtedly present, but more so in the isolated, often thinly populated areas of the Outer Provinces, than in Java.

4. PRODUCTION OF STABLE DRIED VACCINE

The figures of Table III show a good response rate to primary vaccination at least during the 1930's. All vaccine used in the archipelago was supplied by the Government Lymph Institute,⁴ originally in capillaries containing about 0.3 ml of lymph (one part of buffalo

pulp and two parts 80% glycerol). This concentrated lymph had to be diluted before use with glycerol, viz. with 1 ml per capillary in Java (and adjacent islands) and with 0.5 ml in the Outer Provinces, so that final pulp dilutions of 1:13 and 1:8 respectively, were applied.

The supply of remote areas posed large problems and these were met by the development of vaccine dried at room temperature, sealed in vacuo, by Otten.^{8,9} Since 1928 dried vaccine was sent to the most remote and isolated vaccination districts; in 1930 ten districts were thus supplied, ten years¹⁰ later this number had risen to 69 and in 1948¹¹ to 152. Details of vaccine production have later been described by W. A. Collier.¹²

During the development of this process, vaccine potency was tested by primary vaccination infants. It is, however, very difficult to summarize the keeping qualities of this room dried vaccine by exact figures. There is no doubt that this product was markedly superior to glycerolated lymph.⁸ After seven days at 58°C, success rates of 50-100 % were observed and after six months at 37°C the percentages of takes amounted to 80-100.

After 18 years of storage at an average temperature of 22°C, W. A. Collier^{11,12} tested several of Otten's batches, prepared in 1930, had observed 89 successful vaccinations in 159 infants (56%).

5. SMALLPOX FADING-OUT, 1926-1940

As is demonstrated by the figures of Table II, smallpox morbidity decreased markedly - although with interruptions - since 1926. The registration of only 15 cases during the four-year period 1937-1940 could be interpreted as evidence of successful smallpox eradication in a formerly endemic country, bordering an area of continuous endemicity (South-East Asia). Such conclusion infers that all 15 cases could be traced to introduction from outside Indonesia and that existence of continuous endemicity within Indonesia could be ruled out.

It is somewhat disappointing that the available documents that might sustain such a favourable state of affairs are brief in this respect. Nowadays, this seems surprising, but it should be pointed out that the health authorities in this earlier period did not aim at strict eradication but at exclusion of smallpox as a public health problem. They were satisfied to observe that smallpox was at an extremely low level, that major spread was not seen and that special vaccination campaigns to control epidemic foci no longer disrupted the routine of systematic vaccination and revaccination of the population.

The following data could be collected from official sources, from 1937 until the beginning of the war in the South-East Asian area;

- 1937¹³ 1 imported case, Surabaia (port in Eastern Java)
- 1938⁷ 8 cases (1 death) in Western Java, 1 case (1 death) in Eastern Java and 3 mild cases (variolois) in the Outer Provinces
- 1939¹⁴ 2 cases in Western Java
- 1940¹⁵ 2 imported cases, followed after two weeks by 4 cases in Sabang, port at the extreme North-West of the archipelago
- 1941¹⁶ smallpox cases not mentioned (in contrast to plague).

The 1938 and 1939 cases can neither be traced to importation nor to a recognized focus of self-sustaining smallpox. Of course, the validity of the diagnosis may be doubted as it seems highly improbable that the cases were studied by virological methods.

From all available evidence, it is certainly not reasonable to suspect the permanent presence of endemic smallpox in Indonesia during the period 1937-1941. In well vaccinated areas (>80% coverage), smallpox would not have remained unnoticed during a number of months, because these areas were - as demonstrated by their high vaccination rate - rather readily

accessible for the public health service. Areas with low vaccination rates were certainly not a thing of the past but they probably were too isolated or too thinly populated to breed smallpox continuously. Certainly, it is not reasonable to suppose endemicity of smallpox in poorly immunized population groups, which would remain concealed from the civil service and public health officials during one or more years.

A further indirect demonstration of virtual eradication is given by the circumstance that the epidemic spread of smallpox since 1947 can be confidently traced to introduction from outside Indonesia.

6. SMALLPOX RE-ESTABLISHED, 1947

After the second World War a situation arose which favoured the introduction as well as the spread of smallpox:

1. Slackening of routine primary vaccination and revaccination during preceding years of war and its aftermath.
2. High incidence of smallpox in neighbouring areas of South-East Asia, as illustrated by the following figures of notified cases:⁶

	Siam	Malaya	Straits Settlements
1945	34 970	.	.
1946	26 265	3 066	79
1947	1 397	4 600	54

3. A split of governmental authority between two opposing powers, resulting in military actions, uncontrolled traffic and smuggling; an intense traffic of goods between the island of Sumatra and nearby Malaya and Singapore by small Indonesian vessels (proas) has to be mentioned specially.

Smallpox infection of islands in the Riouw-archipelago, south and south-west of Singapore starting in May 1947, was traced back by Van Waardenburg¹⁷ to Malaya. It is worthy of note that a major part in disseminating smallpox was played by an ethnologically peculiar group of people, the Mantangs, sea nomads who preferred to limit their contact with outsiders and also had evaded regular smallpox vaccination in former days as much as possible.

About simultaneously with this outbreak, smallpox occurred also in nearby parts of Sumatra and in 1948 the disease spread to the south-east in the direction of the Strait of Sunda, between Sumatra and Java. According to Gispen,¹⁸ the infection of Western Java presumably dates from September 1948 and the first case recognized in the capital Djakarta (Batavia) from January 1949.

Smallpox has since kept its foothold in Indonesia up to the present day.

7. DISCUSSION

While efforts to check smallpox dissemination in Indonesia started in the nineteenth century, the turn of the tide set in about 1925 and within fifteen years smallpox was virtually eradicated from the vast archipelago. Two changes introduced in the strategy of vaccination coincided with this favourable trend in smallpox occurrence.

First, the dual system of separate rounds for primary vaccination of infants and for revaccination put the vaccinator in a much better situation to cope with. A well defined section of the population - newly born infants - were to be presented at the vaccination

session, or the whole population except young children were to be inoculated. By this policy the local civil servants could co-operate more efficiently and supervision by the regional medical officer during or some time after the vaccinator's presence in an area, was facilitated. Certainly, continuous interest of the medical officer and of the Public Health Service in general, must have been a stimulus for the vaccinator to perform his duties according to the instructions.

Second, a vaccine of improved stability became available when Otten developed a room dried vaccine of high quality. This solved to a very large extent the problems posed by long distances and high environmental temperatures.

The downward trend in smallpox figures depicted by Table II may be attributed to these developments, both leading to a more complete and effective coverage of the population.

8. SUMMARY

Although vaccinia virus was brought to Java in 1804, successful control of smallpox in the Indonesian archipelago was not achieved but after improvement of the vaccination organization and the introduction of stable dried vaccine for remote areas. Between 1930 and 1940 smallpox vanished all but completely from this global area. Since 1947, smallpox re-established itself as an endemic disease, after and during years of political and social confusion that interfered with maintenance of a high immune status by vaccination.

TABLE I. AREA AND POPULATION (1930 CENSUS) OF INDONESIA

Island	Area (x 1000 km ²)	Population (x 1 000 000)	Inhabitants per km ²
Java and Madura	132	42	316
Sumatra	474	8.3	17
Borneo (Kalimantan)	539	2.2	4
Celebes (Sulawesi)	189	4.2	22
Bali and Lombok	10	1.8	175
Other	560	2.5	4

TABLE II. ANNUAL (AVERAGE) SMALLPOX NOTIFICATIONS, INDONESIA⁶

	Java and Madura	Outer provinces
1921	1 445	.
1922	1 236	.
1923	4 922	.
1924	5 941	776
1925	4 658	23
1926	843	12
1927	297	469
1928	46	252
1929	271	343
1930	408	11
1931	69	107
1932	349	213
1933	7	50
1934	4	5
1935	10	33
1936	1	79
1937	1	-
1938	9	3
1939	1	-
1940	-	1
1941-1946	.	.
1947	-	+
1948-1949	+	+
1950	52 228	+
1951	100 952	+
1952	9 819	+
1953	2 584	+

. = no data

- = no cases

+ = cases present, but no final data available from reference 6

TABLE III. ANNUAL (AVERAGE) NUMBERS OF PRIMARY VACCINATION AND OF REVACCINATION IN INDONESIA (IN THOUSANDS)⁷

	Java and Madura					Outer provinces				
	1920	1925	1930-32	1933-35	1936-38	1920	1925	1930-32	1933-35	1936-38
Primary vaccinations	783	1 108	1 331	1 401	1 306	330	379	418	456	525
results checked	650	885	1 087	1 158	1 061	154	135	253	291	346
percentage successful	98.1	93.6	98.7	98.6	98.4	92.3	90.7	94.1	94.8	94.5
Revaccinations	2 655	1 844	2 964	4 520	4 624	612	775	851	1 124	1 264

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The purpose of the WHO/SE/- technical information series of documents is to acquaint interested research and public health workers, as well as WHO staff, with the progress of smallpox research and eradication by means of:

- (1) summaries of some relevant problems of fundamental, epidemiological and operational aspects;
- (2) field project reports and other communications on particular research and eradication aspects which would not normally be published by WHO or elsewhere;
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