



SMALLPOX ERADICATION

Report by the Director-General

I. INTRODUCTION

The Eleventh World Health Assembly, in June 1958, passed a resolution WHA11.54 requesting the Director-General to report to the Executive Board at its twenty-third session on the implications of a smallpox eradication programme.

A report was prepared and presented to the Executive Board. The Board noted this report, made certain recommendations to those countries where smallpox is still present, and requested the Director-General to report again to the Twelfth World Health Assembly on further developments (EB23/R.71).

A questionnaire on smallpox was circulated to all countries on 14 October 1958. Twenty replies had been received at the time when the report to the Executive Board was prepared, and since then another thirty countries have replied. The information thus provided has been of great assistance in the preparation of this present report. There are however still a number of countries, including some in which smallpox is an important problem, which have not yet replied. The information reported here is therefore incomplete and it has been necessary, particularly in connexion with the financial considerations, to make calculations in general terms.

In this document an attempt is made to review the whole situation and to set out the essential factors of a world-wide smallpox eradication programme. The problem is discussed, as it exists at the present time, region by region. An outline is given of the more important technical considerations that must be borne in mind in organizing an eradication campaign. The administrative responsibilities that such a campaign would involve for individual countries and for WHO Headquarters and regional offices are detailed, and the financial aspects of eradication, for individual countries and for WHO, are considered and estimated.

## II. SUMMARY OF PREVIOUS DECISIONS OF THE WORLD HEALTH ASSEMBLY AND THE EXECUTIVE BOARD

The Third World Health Assembly recommended (WHA3.18) that greater weight should be given to smallpox in the regular programme of the World Health Organization for 1952. The Executive Board at its eleventh session, noting a report submitted by the Director-General dealing with further action on general world health problems, considered that a campaign against smallpox would be suitable for a world-wide programme (EB11.R58). The Sixth World Health Assembly, after considering the resolution of the Executive Board, requested the Board to proceed with a detailed study of the means of implementing such a campaign (WHA6.18). At the request of the Executive Board (EB12.R13), the Director-General carried out with Member States, WHO regional committees and members of expert advisory panels, consultations which were brought to the attention of the Board at its thirteenth session. The Board requested the Director-General to urge health administrations to conduct wherever possible campaigns against smallpox as an integral part of public health programmes and to include where possible additional studies on smallpox in his future programme plans (EB13.R3). The Seventh World Health Assembly considered the results of the study carried out by the Executive Board and requested the Director-General:

- to continue studies on the most effective methods of smallpox control, particularly with reference to those countries where the disease is endemic;
- to urge health administrations to conduct, wherever possible and necessary, campaigns against smallpox as an integral part of the public health programmes;
- to provide within budgetary limitations the assistance requested by national administrations to further their smallpox control programmes (WHA7.5).

The Director-General called the attention of all Member States to these resolutions as a result of which new requests for assistance were received from twelve countries, many of which have been or are in the process of being implemented. The Eighth World Health Assembly again urged health administrations to conduct where necessary campaigns against smallpox as an integral part of their public health programmes (WHA8.38).

### III. THE PRESENT-DAY PROBLEM, BY REGIONS

#### 1. Europe

Smallpox is normally not present in any country of the European Region. Cases are introduced from outside occasionally, but the resulting outbreaks are controlled by ring vaccination, and secondary cases are few. Full official information on Romania and USSR is not available, but a recent report from Romania reveals one case of varioloid in 1955 and none in 1956, and at the Tenth World Health Assembly Professor Boldyrev, USSR, stated that there is now no smallpox in the USSR.

#### 2. Americas

Eradication of smallpox from the American Region is proceeding satisfactorily. Smallpox was mildly endemic in the United States of America before the war but, contrary to the usual tide of events, it was virtually eradicated there during the war. No smallpox has been reported since 1953. It was heavily endemic in several South American countries, but most of these in the last few years have given classic demonstrations of the efficacy of planned mass vaccination. In Central America and the Caribbean islands smallpox has not been prevalent for several years.

The report of the XV Pan American Sanitary Conference (CSP 15/17 of 2.9.58) gives notification figures for Member countries, including the following:

Country	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Mexico	1 541	1 060	762	27	-	-	-	-	-	-
Paraguay	1 702	179	304	282	797	770	207	57	132	95
Peru	7 105	6 305	3 612	1 218	1 360	172	115	-	-	-
Venezuela	6 358	3 951	2 181	280	109	72	13	2	4	-
Colombia	7 356	3 040	4 818	3 844	3 235	5 526	7 203	3 404	2 572	2 107

In Colombia a nation-wide vaccination campaign was instituted in October 1955, the object being to vaccinate at least 80 per cent. of the population in five years. In Peru a campaign begun in 1950 covered 78.7 per cent. of the population (mostly in 1950-1953). In Mexico it is claimed that the whole country was vaccinated

in 1950. In these last two countries the local public health services are maintaining the vaccination level. In Chile, the local services have been mainly responsible for the vaccination campaign, and there has been no case of smallpox since 1953. There are still some endemic foci in Brazil. The usual technique of campaigns has been house-to-house vaccination, but collection of the population at pre-arranged places and times is also used successfully. Each vaccinator is given a programme so detailed that his supervisor can find him at any time of any day, provided he is adhering to his timetable.

### 3. South-East Asia

In view of the close geographical connexion between India and East Pakistan, the latter is dealt with under the present heading, although it belongs to the Eastern Mediterranean Region. These countries constitute by far the most important endemic focus of smallpox in the world and with Burma must be regarded as the most likely source from which smallpox may be re-imported into other (chiefly Asian and Eastern Mediterranean) countries. The Mecca Pilgrimage, in which hundreds of thousands of persons drawn from most of the countries of the world, converge on Saudi Arabia annually, is important in this respect, but so is ordinary migration. At Penang, between 1948 and 1953 smallpox was detected among Indian deck passengers on four occasions. At Singapore - a longer voyage from India - between 1947 and 1954 smallpox was detected twice and six times in passengers from India and China respectively. Numerous international ports and airports, notably Calcutta, are endemic foci.

Rogers, who studied the epidemiology of smallpox in India for many years, reviewed (1945)<sup>1</sup> the relationship of vaccination and smallpox there, bringing out some facts that do much to explain the persistence of endemic smallpox. By 1937 less than half the population were subject to compulsory vaccination. Even figures of incidence were not available from the princely states, which constitute a large part of the endemic area. The annual incidence of smallpox declined steadily

---

<sup>1</sup> Rogers, L. (1945) Proc. roy. Soc. Med. 38, 135

from 1.032 per 1000 in 1868-1877 to 0.290 per 1000 in 1928-1937, while annual vaccinations rose from a few to 19.1 millions. Over the same period, smallpox deaths per 1000 in epidemic years declined from 2.1 to 0.38.

In the four years 1954-1957, the incidence has shown no sign of decrease:

Country	1954	1955	1956	1957
India	46 629	41 932	45 166	74 416
E. Pakistan	446	1 879	5 170	24 621

It seems that the persistence of smallpox in India and East Pakistan is due mainly to the variable efficiency with which local authorities, whose responsibility it is, carry out vaccination. Nevertheless, in apparently well-vaccinated provinces such as Bombay and Madras the disease persists. In 1955 Professor C. H. Kempe wrote: "The administrative set-up is unique in Madras, because vaccinators are well-trained and informed and know their respective villages inside-out." Yet Madras reported 2026 and 3418 cases in 1955 and 1956 respectively. Lack of thermostability in the vaccine used must be suspected, and this will be overcome by the use of dried vaccine. It has been proposed that this should be produced locally, with WHO assistance, and WHO has in fact already provided a short-term consultant to advise on the setting up of such producing units in institutes in Patwadangar (Uttar Pradesh) and Guindy (Madras).

At the Eleventh World Health Assembly, India supported the smallpox eradication resolution and "hoped that a time-limit would be set for its completion, because otherwise the necessary steps might not be taken as expeditiously as was desirable".

In the past, Burma was second only to India and East Pakistan as an endemic focus. The latest published figures suggest some recent improvement, but should be accepted with reserve as the annual incidence of disease varies greatly from year to year.

In Thailand only two cases were reported in 1936, but in 1945 and 1946 there were 36 394 and 26 843 respectively. In the four years 1954-1957 annual reported incidence has been 21, 117, 4 and 3 cases. Despite this achievement, remembering the epidemics of 1945 and 1946, there can be no relaxation of precautions while the possibility of fresh importation of infection remains.

In Indonesia smallpox was virtually abolished before the war by intensive vaccination.

Year	1933	1934	1935	1936	1937	1938	1939	1940
Smallpox cases	7	4	10	1	1	9	1	0

It was reintroduced when vaccination was interrupted during the war, spread around the islands, and has been endemic ever since.

Since 1873 Indonesia has possessed a vaccination service, though vaccination has never been compulsory. The system is organized so that on every day of the year it should be possible to state where every one of the 500 vaccinators is working. (It will be noted that this is the system whereby certain American countries have eradicated serious endemic smallpox in three or four years.) Smallpox could be eradicated again, by the existing system, with improved supervision, and use might be made of the yaws campaign. In the resurvey phase a full yaws team sees 6000 persons in four weeks, average attendance being 87.55 per cent. of the population. Supervision is all-important, and yaws campaigns have the power of generating enthusiasm in the supervisory staff. At the Eleventh World Health Assembly, Indonesia undertook to take part in a global eradication campaign.

#### 4. Africa

Since the decline of smallpox in the Americas, Africa is second to South-East Asia as a smallpox focus. The main endemic foci are in Central and West Africa. For some years before the war there was little smallpox in Bechuanaland, Kenya, Nyasaland, Uganda, Northern and Southern Rhodesia, and as few as 90 cases in a year were reported from Tanganyika. It is possible, of course, that there was gross under-reporting; freedom from smallpox was not due to a full vaccination state. Since the war, all the Central African territories have consistently reported smallpox. Northern Rhodesia and Nyasaland have a fairly high incidence. In South Africa endemic smallpox has been reduced to nil since certain previously inaccessible areas were opened up: undoubtedly South Africa and Southern Rhodesia could eradicate the disease permanently but for presumably frequent importations.

The Belgian Congo is an important endemic focus, in spite of having an efficient field medical service. The Belgian Congo and French Equatorial Africa link West with Central and East Africa, and smallpox in the Congo constantly threatens the Federation of Rhodesia and Nyasaland, and Uganda.

In considering smallpox in West Africa, it is necessary to give a sketch of the epidemiology. Smallpox is a predominantly respiratory (droplet) infection, though living virus has been found in the dust of a room nine months after a case of smallpox had lain there, and the virus lives for some time in dry crusts even in daylight: survival of at least 417 days in dry crusts kept in the dark has been proved. Smallpox flourishes in conditions of low absolute humidity and therefore tends to become epidemic in a spectacular manner during the dry season in dry places, typically in the arid countries bordering on the Sahara Desert. In these countries, epidemics die out at the end of the dry season. Unlike the other great airborne epidemic disease of these countries, cerebrospinal meningitis, smallpox can maintain itself in the humid forest areas nearer to the coast almost regardless of season, provided that there is a high population density. It is in fact an endemo-epidemic disease in the humid areas, but in the savannah and arid areas it occurs in epidemics with intervals of complete absence.

The main West African foci are Nigeria, where recent epidemics have been occurring mainly in the densely populated forest areas, and French West Africa, where the highest incidence has been reported in Dahomey and the Ivory Coast (which adjoin the coast and are at least partly forest areas) and Sudan and Niger (which adjoin the Sahara). In Ghana there has not been an epidemic in the savannah area since 1947, but endemo-epidemic cases have been occurring in the forest country. All these countries have efficient field medical services, derived originally from sleeping-sickness campaigns, and consequently focused on the savannah. These services carry out systematic vaccination. Though all are extending their orbits outside the old sleeping-sickness areas of the savannah (roughly from  $8^{\circ}$  to  $13^{\circ}$ N) it is significant that the present areas of high smallpox incidence are those most remote from the field medical services.

From West Africa there is considerable migration eastwards, on the pilgrimage to Mecca. Many, perhaps most, of the pilgrims travel on foot. They have no respect for frontiers and though the Sudan immigration authorities do their best, the latter country is constantly threatened with smallpox from this source. Egypt may be infected via the Sudan, or by travellers from India.

##### 5. Eastern Mediterranean

Egypt became reinfected during the war, and the following table illustrates the possible disastrous consequences of such an importation:

Year	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
Smallpox cases	2	0	0	4 138	11 194	1 355	416	170	16	3

East Pakistan, which belongs to this Region, has already been referred to in conjunction with India. Mention has already been made of the pilgrimage to Mecca, which is of vital concern to this Region, being in the very centre of it. Because of the volume of international traffic, mainly by land, and the absence of quarantine land barriers between many of the countries in this Region, smallpox may easily spread from endemic zones to countries that are free of the disease.

The WHO Regional Office for the Eastern Mediterranean has set up a team, consisting of an epidemiologist and a laboratory expert, to carry out a smallpox survey of the countries in this Region, and action will be taken in the light of results of this. In the meantime, equipment has been provided by WHO for the production of freeze-dried vaccine in seven of the countries in the Region (Iran, Iraq, Israel, Pakistan, Sudan, Tunisia, United Arab Republic - Provinces of Egypt and Syria). A seminar on smallpox control is planned for 1960.

In the Province of Syria a mass vaccination campaign was conducted in 1957 under the control of the national authorities and no difficulty is seen as far as an eradication programme is concerned. In Iran, endemic foci exist in the mountain areas with cool, dry climate. A mass vaccination campaign, under the direction of the Ministry of Health, has already covered an area where 13 million out of the total population of 19 million live. It is estimated that 67 per cent. of the population so far covered have actually been protected by successful vaccination, but



that many others are immune from old infection or vaccination. The campaign is expected to be completed very soon, and maintenance of immunity in the population is already planned, so that co-operation with a world-wide programme is assured, if that programme starts soon. (Iran has a long frontier with Afghanistan, in which smallpox has been heavily endemic.)

#### 6. Western Pacific

In 1954, smallpox was endemic mainly in Korea and in Cambodia, Laos, Viet Nam and Thailand. The last named, although belonging to the South-East Asia Region, is mentioned here because of its geographical proximity to Cambodia and Laos. Korea has reported that it has now no endemic foci. Incidence is decreasing in all the other countries. At the Eleventh World Health Assembly, Viet Nam supported the smallpox eradication resolution and, in answer to the Director-General's questionnaire, has stated that between 50 and 60 per cent. of its population are now vaccinated, and that its vaccination campaign should be completed in two years.

In some of the island territories of the Western Pacific smallpox has not re-established itself since dying out before the war. North Borneo and Sarawak are examples. Vaccination is not compulsory in either, and its practice appears to be confined to one or two main towns. Communications with the interior are slow, which doubtless militates against the introduction of smallpox.

### IV. TECHNICAL CONSIDERATIONS

#### 1. Vaccination

It is generally agreed that eradication of smallpox from an endemic area can be accomplished by successfully vaccinating or revaccinating 80 per cent. of the population within a period of four to five years. The only acceptable criterion of successful vaccination is vesiculation: either primary vaccinia or the accelerated reaction. The precious non-vesicular reaction known as the reaction of immunity, or immediate reaction, is not reliable evidence of actual immunity.

## 2. Vaccine

The amount of vaccine required annually for a country's smallpox eradication campaign is calculable in advance, and should be so calculated in order to plan the most economical use of vaccine-producing institutions. Factors involved in the calculation are: the population of the area to be covered, the proportion already vaccinated, the anticipated wastage of vaccine (usually surprisingly low, not more than 5 per cent.). Climate, communications and the proportions of population in rural and urban areas must all be considered in deciding in what proportions to use dried and glycerinated vaccine.

Full details of smallpox vaccines, their preparation, testing, suggested international standards, sources of seed virus, etc., are given in the Report of the Study Group on Recommended Requirements for Smallpox Vaccine, WHO/BS/IR/70 of 27 November 1958, communicated to the Executive Board in document EB23/60, and shortly to be published.

## 3. Freeze-dried vaccine

It is believed that for mass vaccination, especially in tropical and remote rural areas, freeze-dried (lyophilized) vaccine prepared by the Lister Institute technique offers the best results, since it remains viable for at least three months at 37°C and for at least eight weeks at 45°C. No difficulty is involved in teaching its use to semi-educated and uneducated vaccinators. Its preparation is described in Official Records No. 79, page 538.

The production of Lister type dried vaccine demands high standards of skill and responsibility in the professional and technical staff employed. Several important considerations arise, which will affect decisions to give WHO assistance in setting up dried vaccine plants in individual countries.

The professional and technical personnel must be carefully selected with due respect to qualifications and character. Some countries have experienced difficulty in finding suitable staff.

The selected staff must be given fellowships for training. There are at present very few institutions where this type of training can be given.

Although the thermostability of Lister type vaccine is outstanding, dried vaccines prepared by some other processes satisfy the minimal requirement of stability for four weeks at 37°C. WHO fellowships for training in the Lister Institute technique being necessarily limited to a small number, training in other satisfactory techniques must be considered. Most of the dried vaccine for the successful campaigns in Central and South America was produced by techniques developed in the United States of America.

The services of a short-term consultant with the highest qualifications, for a total of two to three months, are required in setting up a freeze-dried vaccine laboratory. Few such men are available at present and their time is heavily committed, which limits the periods of two to three-consultant-months that can be provided annually, and thus the number of producing units that can be set up each year.

The quality of vaccine produced at every laboratory must be subject to continuous checking, to ensure that the standards laid down by the Study Group on Recommended Requirements for Smallpox Vaccine are maintained. The testing procedure requires the expenditure of much skilled time.

One lyophilization unit produces, if all goes well, some 1 500 000 doses of vaccine annually. For this, it requires a full professional and technical staff, including a highly-qualified director. In hot climates an air-conditioned laboratory is also necessary. Admittedly, veterinary and other vaccines may be produced in the same institution simultaneously, thus sharing the overheads. It is obvious that overhead costs per dose will be lower if several units are grouped together.

All that is said above combines to suggest that it is desirable for WHO assistance to be devoted to setting up a few comparatively large, efficient institutions, rather than many small ones, the efficiency of which will be dubious. For a WHO-assisted institution to produce a low standard vaccine may even be damaging to the Organization's reputation.

Glycerinated vaccine lymph will continue to have uses. When refrigerated storage and transport are available it offers the advantage of being cheaper and easier to produce and of being issuable in single-dose containers.

#### 4. Complications of vaccination

Research into the complications of vaccination is proceeding in the Netherlands and in Germany. The most dreaded complication is post-vaccinal encephalitis, which occurs most commonly after primary vaccination of adolescents and young adults. Reported incidence varies from as much as 1:3000 vaccinations down to Cuba's two or three cases since vaccination was started. It is not known if cases have occurred after vaccination with Lister type dried vaccine.

Human immune gamma globulin is under trial in the Netherlands for the prevention of post-vaccinal encephalitis. Results obtained so far indicate that a successful outcome is possible.

In the USSR hyperimmune gamma globulin of very high titre is being produced from lower animals. This offers a much freer supply and the possibility of producing it elsewhere is being examined. Apart from the prophylaxis of post-vaccination complications, it may be useful for aborting overt smallpox in unvaccinated contacts and for treating cases of smallpox. The Study Group on Recommended Requirements for Smallpox Vaccine has recommended that gamma globulin should be made subject to an international standard.

The best prophylactic against post-vaccinal encephalitis is to carry out primary vaccination in the very first years of life.

#### 5. Diagnosis of smallpox

The laboratory diagnosis of smallpox is now a matter of routine in any institution with the staff and equipment required. Laboratory confirmation of the clinical diagnosis is of minor importance in a country with endemic smallpox, but becomes increasingly important as smallpox becomes rare and medical practitioners unfamiliar with its atypical forms. WHO may have to give assistance to some countries in setting up facilities for laboratory diagnosis.

In countries free from smallpox, early recognition of imported cases is of the greatest importance. Apart from laboratory diagnosis it may also be desirable to provide short fellowships to selected medical officers in such countries to become familiar with the clinical aspects of smallpox in an endemic area, and thereafter to act as consultants in their own country.

## 6. Research

The Study Group on Recommended Requirements for Smallpox Vaccine has drawn attention to those aspects of smallpox and vaccination into which research, particularly research by modern virological methods, is still needed.

## V. ADMINISTRATIVE CONSIDERATIONS

### A. Individual countries

#### 1. Responsibility for the smallpox service

Some countries, e.g. Indonesia, have a separate vaccination service, but in most countries vaccination and all other aspects of smallpox eradication, will have to be integrated with the general public health services. However, smallpox eradication must be directed, or at least co-ordinated, centrally. With this arrangement, it is essential that at medical headquarters, both at country and provincial level, there shall be someone charged specifically with responsibility for smallpox eradication. If, as is possible, this director has other duties to perform in addition, he must have an assistant with ability and a positive personality who is solely concerned with smallpox eradication. A clear line of command must exist from the vaccinator in the field to the director in the highest place in medical headquarters, who is responsible for information, finance, stores, transport, staff welfare and every other administrative factor. In the absence of such a line of command it is usually found that the affairs of a remote field campaign get low priority as compared with those interests closer at hand and more clamorous.

2. Scope of the smallpox service

The work of the smallpox service should include the following:

the mass vaccination campaign;

health education (including explanation of the reasons for the campaign, and a positive element of publicity);

diagnosis and isolation of cases of smallpox, and surveillance of contacts;

all aspects of quarantine.

3. Legislation

In some countries legislation regarding smallpox vaccination will have to be introduced. Smallpox vaccination: A survey of recent legislation, reprinted by WHO, 1954, from International Digest of Health Legislation, 1954, 5, 221-262, gives adequate guidance on this subject.

4. Preparation of a programme

A programme of the campaign should be prepared, detailed geographically and by time period, including vaccine requirements and transport arrangements. As far as the time period is concerned, four years (the period envisaged in resolution WHA11.54) is probably ideal technically, being roughly the length of time for which successful vaccination confers full immunity. Administratively it may be easier to plan for a rather longer time, say five years, in a country such as India, with a big population and much preparatory work involved. The time period should be co-ordinated as closely as possible between adjacent territories and (as stressed by India at the Eleventh World Health Assembly) it should be laid down in advance.

5. Appointment of staff

The all-important consideration is that no campaign can possibly succeed unless the two qualities of ability and enthusiasm are equally present in the directing and supervising staff. This principle has already been stressed by WHO in planning the global malaria eradication campaign. The first step in

building up the smallpox eradication staff must be the recruitment of a directing cadre which must supply throughout the initiative and drive to carry through the campaign. This directing cadre must be drawn from the country's own nationals, though WHO may provide epidemiologists or laboratory workers as short-term consultants.

Medical supervision of the vaccinators' work is necessary, and there should be sufficient full-time medical officers concerned with the campaign to ensure that any inspector could call out a medical officer reasonably quickly in an emergency.

The work of vaccinators must be supervised constantly and strictly by inspectors who, however, must be on sympathetic terms with the men under them. It may be hard to find sufficient men of the calibre and integrity required for inspectors. Information in the smallpox questionnaires suggests that one inspector can usually supervise from seven to ten vaccinators, though the number is as few as four in a particularly scattered rural area.

Successful performance of the act of vaccination is extremely simple, and it is easy to train even illiterate workers to vaccinate satisfactorily. It is equally easy to vaccinate unsatisfactorily, and this is why supervision, constant, strict, but sympathetic, is a necessity.

Some countries have the means and manpower to recruit as many vaccinators as they need; others lack both funds and persons potentially qualified for the work, and have already reported to WHO that they would need special help from the Organization to enable them to carry out mass vaccination.

The setting up of an organization for the planning and administration of smallpox eradication, and training of supervisors and vaccinators, will take time and must be considered as a matter of the utmost urgency.

## 6. Planning the vaccination campaign

There are two possible systems for mass vaccination: house to house or at fixed collecting points. The latter system enables the vaccinators to carry out more vaccinations per day, but in general experience indicates that nowhere near

80 per cent. of the population attends. The house-to-house method requires greater effort and more intensive work, but it does ensure a better coverage of the population. The house-to-house method has been followed in several countries which have already successfully achieved eradication by mass vaccination, and it is being followed by other countries which are developing their programmes at the present time. In most areas this method must certainly be adopted. Whichever method is used, however, it is essential to warn people in advance of the date and time when they will be vaccinated.

It is most important to calculate the average number of vaccinations which one vaccinator can perform annually or daily in the conditions prevailing locally, since the whole timing and staffing of the campaign depends on this. Experience indicates that the average number of vaccinations which one vaccinator can perform varies greatly; only 7000 a year in one rural area in Africa, with individual scattered houses and a long, immobilizing wet season; 22 000 and 15 600 respectively in two Eastern Mediterranean countries; 60-80 daily as a general average in South America; as many as 150-250 daily in urban areas.

The nature of communications and the type of transport available are important factors in the output of vaccinators. According to the distances to be covered and the effect of rain on communications, the number of days of actual vaccinating worked annually by each vaccinator may vary from less than 200 to 310. Some countries have successfully used motor-carried teams of vaccinators. This method saves much time if the area is composed of well-defined villages, but would be ineffective in one with many isolated dwellings.

#### 7. Combination with other campaigns

Smallpox vaccination can be combined with the activities of other campaigns, provided that the component operations fit together in their timing. Yaws campaigns combine particularly well with vaccination, as has been found already in Haiti and Nigeria. Needless to say, the administration of vaccinators working with other campaigns must continue to be the responsibility of the smallpox eradication service.

#### B. WHO Headquarters

For WHO Headquarters to fulfil its proper role in stimulating and co-ordinating the work of smallpox eradication throughout the world, WHO Headquarters must establish contact with all those institutions and expert consultants who could assist in this work.



There are at present very few institutions where fellows can be properly trained in the techniques of freeze-dried vaccine production, and these same institutions are the only ones where the quality of freeze-dried vaccine from WHO-assisted laboratories can be checked. Moreover the very few men qualified to help as short-term consultants in the setting up of new WHO-assisted producing laboratories, and periodically to inspect such laboratories, are likely to be on the staff of these institutions. Careful administrative planning will be needed to ensure that the facilities these institutions may be willing to offer to WHO are used to the best possible advantage. Detailed arrangements will have to be made with these institutions.

The organization of training courses in vaccine production will be one of the responsibilities of Headquarters, since in this way participants from several regions can be brought together and the maximum use made of the services of the consultant-instructors. This will also avoid undue pressure on the institutions to take individual fellows for training.

To facilitate co-ordination of the work in different regions, inter-regional conferences will be desirable from time to time, and Headquarters will organize these.

The recruitment of epidemiological consultants will be an appropriate headquarters activity, in view of the possibility of dovetailing together several short-term appointments of this type, to make the most effective and economical use of the experts available.

Gifts of vaccine have already been offered by two countries (USSR and Cuba) for use in the world-wide smallpox eradication campaign.

C. WHO regional offices

1. Organization of regional conferences

Such conferences serve several important purposes: they form an outward and visible manifestation that the subject with which they are concerned is regarded as truly important; they provide participants from different countries with the opportunity to meet personally, to exchange information and to co-ordinate their programmes; they call for up-to-date reports to be made in public, and this acts as a spur to countries whose campaigns might otherwise languish; and attendance at such conferences raises the status in their own countries of participants and consequently of the work they are doing

## 2. Fellowships

The award of fellowships will require careful planning and administration, especially as regards timing, and making the best use of places offered in inter-regional training courses. This applies especially to awards to medical laboratory workers, to study production of dried vaccine and laboratory diagnosis of smallpox, and for technical laboratory workers to study the working and maintenance of dried vaccine plant. In addition, provision will be desirable for epidemiologists to study the administration and field work of successful campaigns in other countries, and for clinicians in those countries where smallpox is now rare, but liable to be re-imported, to study the clinical aspects of smallpox in order thereafter to act as consultants in their home countries.

## 3. Supplies

It will be necessary for WHO, through the regional offices, to supply equipment for the production of dried vaccine to certain selected laboratories.

## 4. Vaccine programmes

The regional offices will have to consolidate the vaccine requirements of the different countries in the region and co-ordinate the work of the vaccine-producing laboratories. To ensure economy and efficiency, it may be desirable to organize the distribution of vaccine between countries in the region.

# VI. FINANCIAL CONSIDERATIONS

## A. Individual countries

### 1. Budget provisions

From information received in the questionnaires it is difficult to present an overall picture of the present financial provisions throughout the world for smallpox control and eradication, mainly because in many places the cost of smallpox control cannot be distinguished from the general public health budget, of which it forms an integral part. However, it is obvious that in those countries where smallpox is endemic considerable expenditure must already be incurred for administration, vaccination, isolation and quarantine.

In those countries where eradication has recently been achieved through mass vaccination campaigns, it has been found that special separate budgetary provision for smallpox eradication is most desirable.

In working out a vaccination campaign budget it should be possible to calculate a per capita cost figure and apply this to the whole country by cautious extrapolation. Components of the per capita cost are:

- Directing staff
- Administrative staff
- Supervisors
- Vaccinators
  
- Transport
- Maintenance of transport
  
- Miscellaneous provisions, i.e.
  - Vaccination equipment
  - Containers for transport of vaccine
  - Buildings for use as local stores, etc., if necessary
  - Stationery
  - Uniform for staff
  
- Vaccine
  
- Isolation services
  
- Quarantine services

Some actual examples, taken from national eradication campaigns, may be interesting:

Columbia. This country started a mass vaccination campaign in 1955 with the aid of PAHO and UNICEF. In another two years (1959 and 1960) it is planned to complete vaccination of the entire country. The national campaign is under the direction of the Health Ministry (Epidemiology Section) but has its own full-time staff consisting of three medical officers, a paymaster, 11 inspectors, 110 vaccinators and 14 drivers. The work is done by mobile teams, going from house to house. Motor transport is used, and also horses for the rural areas. The average number of vaccinations carried out by each vaccinator is 60-80 per day, and the average cost is estimated to be about eight cents (US) per vaccination.

Iran. In this country a campaign is under way and it is planned to vaccinate the whole population in three years. The campaign is under the direction of the Ministry of Health, but the smallpox service has its own full-time staff. In each of the 11 provinces there is a physician in charge of smallpox eradication, with necessary clerical staff. A total of 250 vaccinators is employed throughout the country, in 50 teams of five. Each team has a jeep and in mountainous areas horses, mules and donkeys are also used to enable the vaccinators to go from house to house. Inspectors are attached to each provincial office to help the physician in supervision of the work. The average number of persons vaccinated each year by each vaccinator is approximately 22 000. The cost per vaccination works out at about eight cents (US).

Peru. A five-year mass vaccination campaign has already been carried out in Peru and now the whole country is being covered again, which will take a further five years. Since 1954 no case of smallpox has been reported. The national campaign is directed by the Immunisation Department of the Ministry of Health and has a central office in Lima and three regional offices in different parts of the country. Exclusively for the smallpox campaign there are eight full-time medical officers. Vaccinators work in teams, ten vaccinators to each supervisor. At present there are 97 persons employed full-time on this work (including supervisors, vaccinators and auxiliary staff). Each vaccinator carries out an average of 50 vaccinations per day, working from house to house. It is estimated that the average cost per vaccination is about ten cents (US).

More information will be needed before a detailed study can be made of the probable cost of eradication in most countries, but in the meantime the following table, showing the average cost per vaccination in some countries which have provided figures, may be interesting:

Country	Vaccinations per vaccinator	Estimated average cost per vaccination (in US dollars)
Iran	22 000 per year	0.08
Peru	60-80 per day	0.10
Philippines	65-80 per day	0.10
Ecuador	60-80 per day	0.07
Colombia	60-80 per day	0.08
Korea	-	0.08
Thailand	-	0.075
Venezuela	60-80 per day	0.11

These figures are all based on house to house vaccinations. They include cost of personnel, transport and miscellaneous provisions, but not vaccine. It is difficult to calculate the cost of vaccine per person, as in many countries there is no separate accounting procedure for smallpox vaccine, which is produced together with other vaccines in central laboratories. The cost per person is in any case low, and where figures have been given they vary from \$ 0.0049 to \$ 0.067 per dose for dried vaccine, and \$ 0.002 to \$ 0.017 per dose for glycerinated vaccine.

Assuming for the purpose of estimating that the average cost throughout the world for mass vaccination will be US \$ 0.10 per person vaccinated, or \$ 100 000 per million of the population, some idea of the magnitude of the problem is given in the following tables. These tables show the countries and territories in the different WHO regions in which smallpox still exists, with their latest available population figures (usually as at 1956 but sometimes later). Reported smallpox cases for 1956, 1957 and 1958 are shown. Those countries which have had no autochthonous cases during these three years are not included in the tables. In the final column is shown the estimated cost of vaccinating the entire country. The countries concerned will of course be spending quite considerable sums already for the control of smallpox, but the amount indicated in the final column of the table will in most cases be appreciably higher than the present authorized budget provisions for this purpose. After successful mass vaccination has been carried out, however, comparatively small budgets will suffice for the maintenance of a state of immunity.

Country or territory	Population (1000)	Smallpox cases			Cost of total vaccination \$ US
		1956	1957	1958	
<u>Africa</u>					
French Equatorial Africa	4 900	57	57	14	490 000
French West Africa	19 200	4 855	12 873	6 612	1 920 000
Angola	4 392	106	11	135	439 200
Bechuanaland	334	-	111	96	33 400
Cameroons (French)	3 240	42	4	10	324 000
Belgian Congo	13 100	4 663	2 032	1 289	1 310 000
Gambia	290	15	33	21	29 000
Ghana	4 836	259	184	166	483 600
Portuguese Guinea	559	4	149	41	55 900
Kenya	6 351	396	806	735	635 100
Liberia	1 250	...	...	5 569	125 000
Mozambique	6 234	4	-	-	623 400

- Nil

... Data not available

Country or territory	Population (1000)	Smallpox cases			Cost of total vaccination \$ US
		1956	1957	1958	
<u>Africa (cont.)</u>					
Nigeria	32 433	4 614	9 733	1 855	3 243 300
Rhodesia & Nyasaland	7 650	974	915	510	765 000
Ruanda-Urundi	4 510	58	34	29	451 000
Sierra Leone	2 120	946	4 845	512	212 000
Somaliland (British)	650	-	3	-	65 000
Tanganyika	8 916	605	856	1 176	891 600
Togoland (French)	1 085	6	11	29	108 500
Uganda	5 767	231	481	418*	576 700
Zanzibar	285	52	1	1*	28 500
<u>America</u>					
Argentina	20 255	86	336	22	2 025 500
Bolivia	3 311	481	1 310	193	331 100
Brazil	59 846	2 385x	1 014x	...	5 984 600
Colombia	13 522	2 572	2 103	1 669	1 352 200
Ecuador	4 007	669	913	821	400 700
Paraguay	1 638	132	103	21	163 800
Uruguay	2 650	42	2	-	265 000
<u>Eastern Mediterranean</u>					
Ethiopia	20 000	555	403	573	2 000 000
Libya	1 136	-	2	-	113 600
Sudan	11 037	438	285	46	1 103 700
Tunisia	3 815	2	-	-	381 500
Iran	19 723	1 616	1 008	311	1 972 300
Iraq	6 538	2 173	1 922	6	653 800
Lebanon	1 525	84	108	-	152 500
Pakistan	85 635	5 323	25 770	49 912	8 563 500
Saudi Arabia	6 036	-	65	142	603 600
Yemen	4 500	...	...	20	450 000
Somaliland (Italian)	1 310	84	-	-	131 000
Aden Colony	152	-	13	67	15 200
Aden Protectorate	650	-	48	97	65 000
Bahrein	124	61	7	-	12 400
Kuwait	208	8	23	-	20 800
Muscat and Oman	550	22	4	9	55 000
Qatar	40	4	2	-	4 000
Trucial Oman	80	3	-	-	8 000

- Nil

... Data not available

\* Imported

x Cases reported from F.D. and State capitals only

Country or territory	Population (1000)	Smallpox cases			Cost of total vaccination \$ US
		1956	1957	1958	
<u>South East Asia</u>					
Afghanistan	13 000	1 002	239	287	1 300 000
Burma	20 054	4 223	2 739	1 663	2 005 400
Ceylon	9 165	-	19	36	916 500
India	392 440	45 166	78 896	167 437	39 244 000
Portuguese India	649	1	42	98	64 900
Indonesia	85 100	2 817	1 550	3 051	8 510 000
Thailand	21 076	4	3	28	2 107 000
<u>Western Pacific</u>					
Cambodia	4 600	525	111	16	460 000
Korea (South)	22 655	9	7	9	2 265 500
Viet Nam (South)	12 300	256	83	30	1 230 000

- Nil

B. WHO Headquarters

1. Staff

It is clear that the development of a world-wide smallpox eradication programme will require an increase in the financial provision for staff. As a beginning, provision is made in the proposed budget for 1960 for a medical officer to devote his full time to this work. Provision will also have to be made for short-term consultants as it may be desirable (particularly in the case of epidemiological consultants and laboratory experts) to plan for combined assignments involving visits to more than one region.

2. Vaccine

The distribution of international vaccine supplies will need special financial provision for fees to testing laboratories and transport arrangements.

3. Conferences

Periodically, inter-regional conferences will be necessary to ensure co-ordination of the work throughout the world. As a beginning, such a conference is planned for 1960, to include participants from EMR, SEAR and WPR.

#### 4. Training courses

To ensure maximum and most economical use of the services of the few available experts in this field, training courses are planned, to provide instruction for participants from several regions. The first two such courses will be organized in 1960, on dried smallpox vaccine production.

#### C. WHO regional offices

##### 1. Conferences

Inter-country conferences will be most useful for stimulating and co-ordinating the work within regions. The first such conference is to be organized by AFRO in 1959.

##### 2. Fellowships

Funds should be earmarked well in advance to ensure that fellowships can be made available as needed by the different countries to train their own nationals for key posts in the eradication campaign. As a beginning, four fellowships were awarded in 1958 for doctors to study dried vaccine production in 1959. Financial provision for more of these fellowships will be needed, as well as for the other types mentioned above.

##### 3. International field staff and consultants

In the Eastern Mediterranean Region, a team of two experts (an epidemiologist and a laboratory expert) is at present carrying out a survey of the smallpox situation, as a preliminary to planning eradication. In Africa a consultant is to visit a number of countries in 1959 to help in the planning and organization of eradication. In South-East Asia provision is made for a consultant in 1959 to investigate the persistent high prevalence of smallpox and to advise the governments. Following this visit, provision is made in 1960 for a medical officer to work with the national personnel in a selected area, to organize and establish an efficient smallpox service.

In several regions there are calls for laboratory consultants for three month assignments - some of these might be dovetailed into one combined assignment. Epidemiological consultants will also be needed. In South-East Asia, where international epidemiologists have already been working for some years in two countries, a third is expected to start work in 1959. Though these epidemiologists are concerned



with all communicable diseases, the control and eventual eradication of smallpox is an important part of their work.

4. Vaccine

There is insufficient information on which to base estimates of the amount of vaccine that will have to be supplied internationally. Most countries can produce more than enough glycerinated vaccine for their own needs. When the regional offices have worked out the needs for their regions it will be found no doubt that more dried vaccine producing plants are required. Each unit costs \$ 5000 to \$ 7000 to purchase, deliver and instal, and will then produce about 1 500 000 doses annually. Several have already been supplied by WHO.

5. Summary of expenditure by WHO on smallpox

The following table indicates the sums provided in the WHO budget for smallpox control and eradication in the years 1958, 1959 and 1960 (Official Records No. 89):

Region	Funds	1958	1959	1960
Africa	Regular funds	7 300	11 120	-
Americas	Regular funds	44 387*	11 899	12 159
	PAHO funds	70 335*	85 471	79 559
South-East Asia	Regular funds	15 510	3 900	14 286
	UNICEF funds		16 000	
Eastern Mediterranean	Regular funds	7 000	28 649	46 236
Inter-Regional	Regular funds	-	-	38 400

\* includes the Haiti campaign, which was for yaws and smallpox eradication

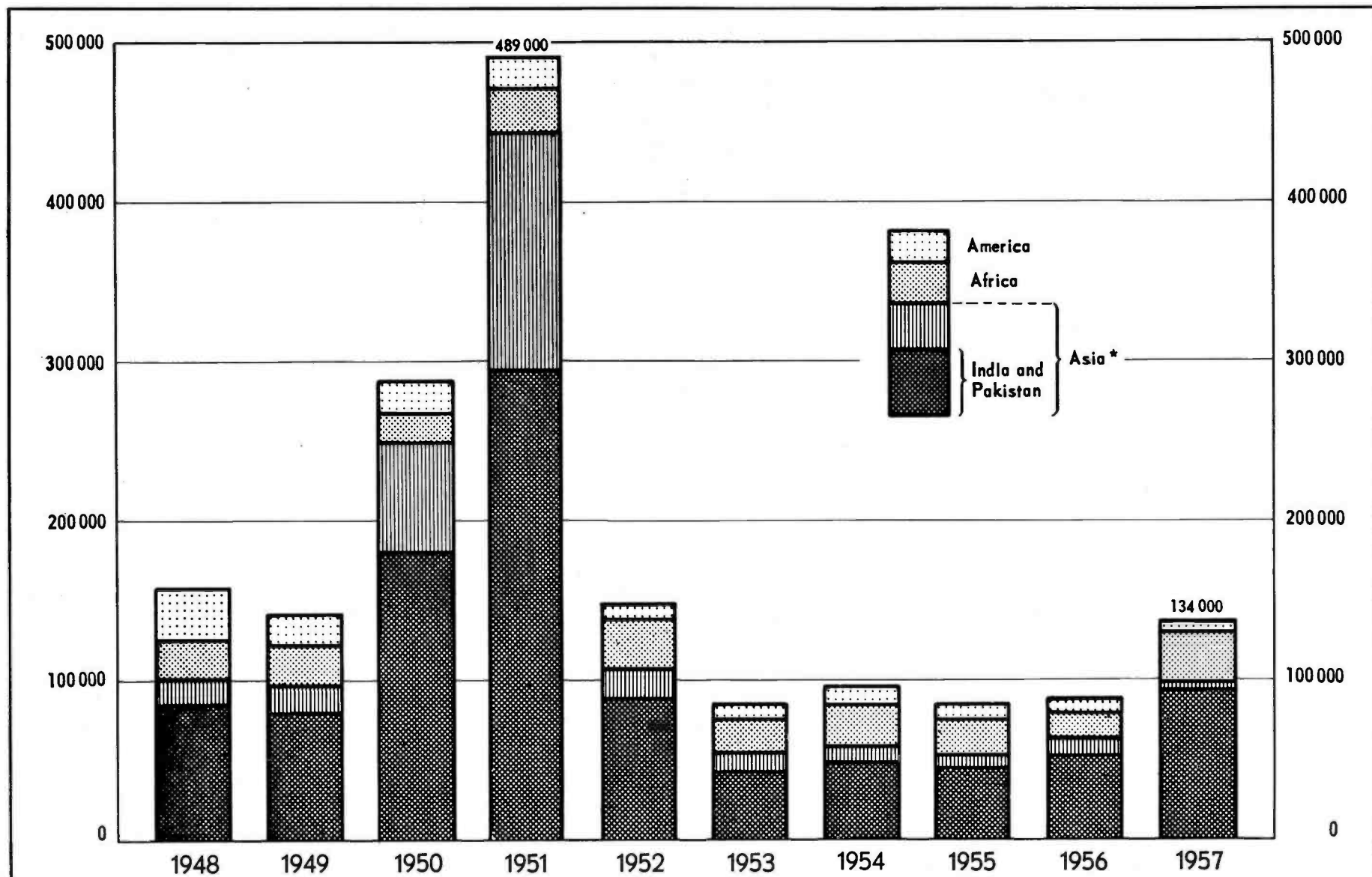
Figures for earlier years would show considerable expenditure only in the Americas, where an eradication campaign has been going on since 1952. In that year the Directing Council authorized expenditure from PAHO funds of \$ 75 000 for smallpox eradication, and in 1954 the XIV Pan American Sanitary Conference approved an additional amount of \$ 144 089 to be utilized for the co-ordination of a continent-wide eradication campaign. This was all spent by the end of 1957, and it will be seen from the table above that large sums are again set aside for the years 1958-1960 to continue the work.

In other regions there has not yet been a concerted effort to eradicate smallpox, although opportunity has been taken by WHO whenever possible to assist governments by providing short term consultants and fellowships under the general heading of "communicable disease control" or "laboratory services", which in many cases included an element of work on smallpox. It is not possible to show exact figures of expenditure incurred specifically for smallpox, however. In any event it will be clear that the amounts devoted to smallpox control and eradication from WHO budgets in past years have been very small in relation to the magnitude of the task. Following the resolution of the Assembly, the Director-General has informed all governments that WHO is ready to receive requests for assistance in this field.

#### SUMMARY AND CONCLUSIONS

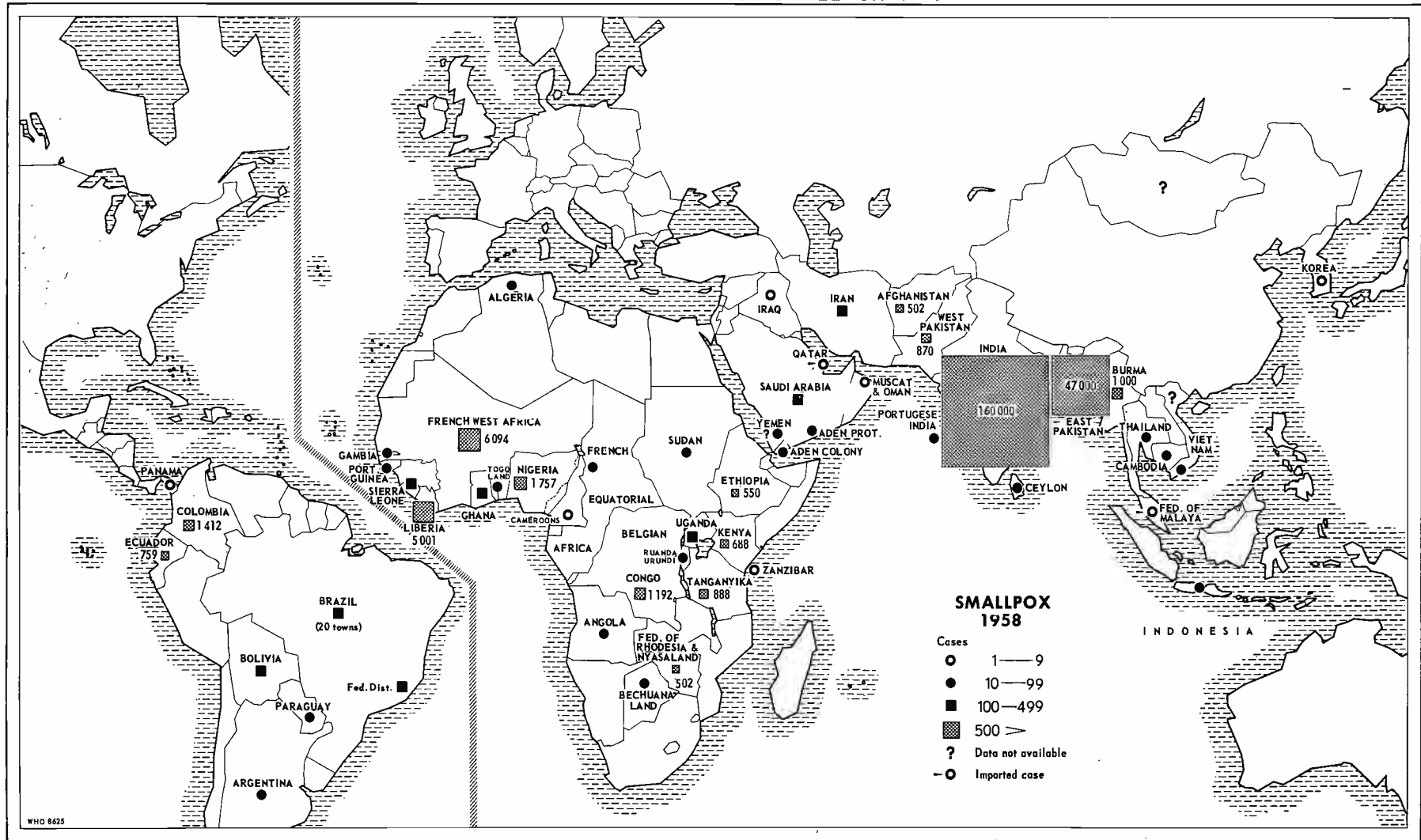
In this document, in accordance with resolution WHA11.54, the current status of the smallpox problem in the world has been reviewed, and guiding lines are given on which an eradication programme may be based. Such financial implications as can be set down at the present time are included. A more detailed plan, with financial details, can only be prepared when further consultations with Member States and in some instances further investigations within countries are completed.

NOTIFICATION OF SMALLPOX CASES BY CONTINENTS\*, 1948-1957



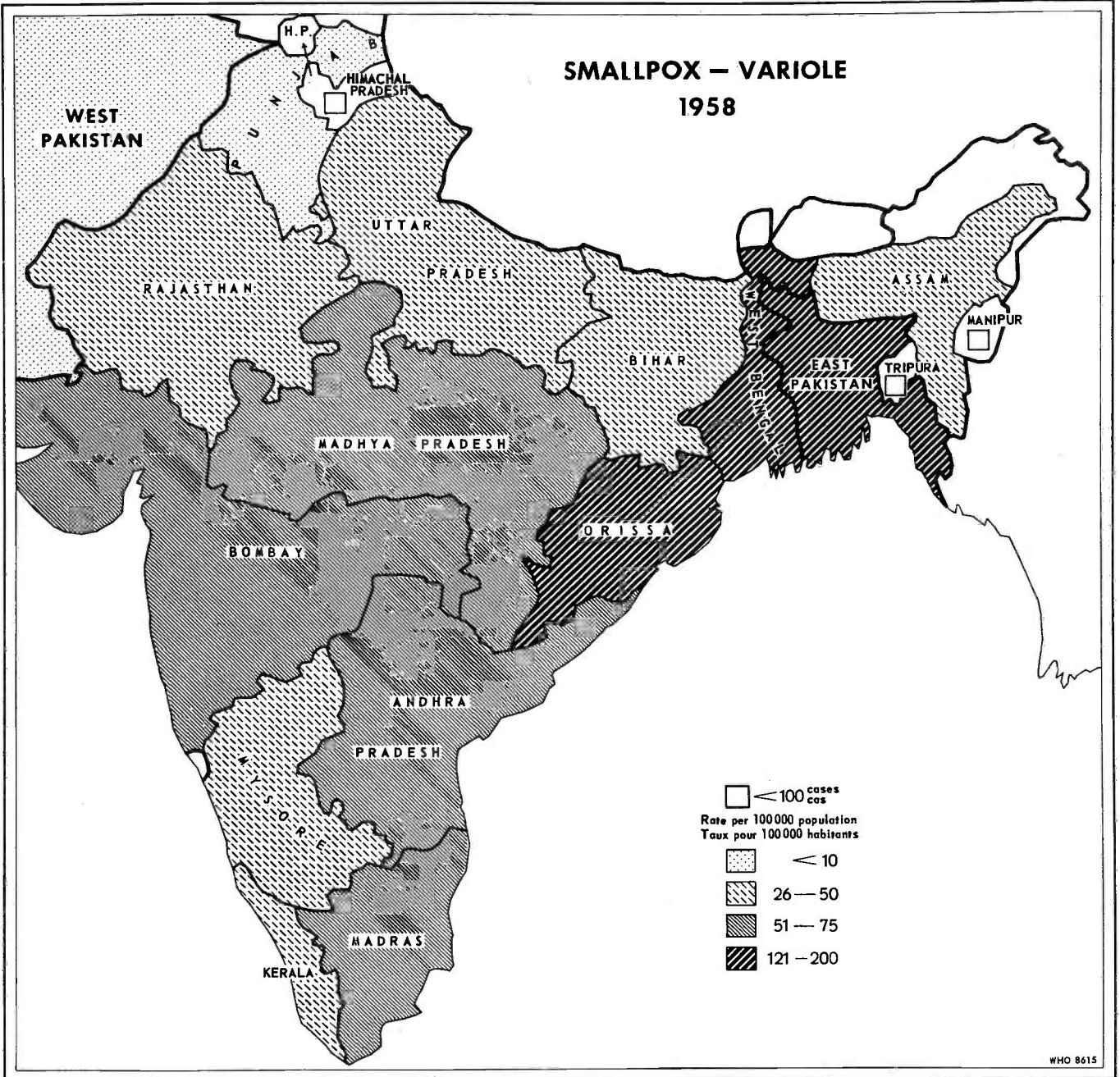
\*Excl. USSR and Continental China

# NOTIFICATION OF CASES OF SMALLPOX IN 1958



DISTRIBUTION OF SMALLPOX IN THE STATES OF INDIA AND IN E. AND W. PAKISTAN, 1958,  
 ACCORDING TO PROVISIONALLY NOTIFIED CASES

DISTRIBUTION DE LA VARIOLE DANS LES ÉTATS DE L'INDE ET AU PAKISTAN ORIENTAL  
 ET OCCIDENTAL, 1958, D'APRÈS LES NOTIFICATIONS PROVISOIRES DES CAS



NOTIFICATION OF SMALLPOX CASES IN PORTS AND AIRPORTS, 1958  
 NOTIFICATION DES CAS DE VARIOLE DANS LES PORTS ET AÉROPORTS, 1958

