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ORGANIZATION OF A SMALLPOX ERADICATION SERVICE

Introduction

In June 1958 the Eleventh World Health Assembly resolved that immediate efforts should be made to eradicate smallpox from the world.

Since the introduction of vaccination, most countries with temperate climates have rid themselves of endemic smallpox, but in many tropical and subtropical countries the disease still persists.

The eradication of smallpox presents no insuperable difficulties in any country. It has been claimed that, in some tropical countries known to have had well-organized medical services for a long time, mass vaccination does not control endemic smallpox. Closer examination of the information available reveals that this is a false conclusion. Nearly always the persistence of smallpox can be explained satisfactorily by the fact that vaccination coverage of the area concerned is patchy. Often, for example, a few urban areas may be vaccinated year after year, providing annual vaccination figures of impressive size, while rural areas receive little or no attention.

There are areas, with hot climates and poor communications, in which it can be suspected that inactivation of vaccine through exposure to heat before use is at least a partial cause of the failure of mass vaccination. The development of thermostable dried vaccine has now overcome that difficulty.

That mass vaccination can be effective in tropical and subtropical areas is shown by the results of recent campaigns in some countries with long-established endemic foci of smallpox.

Country	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Mexico	1 541	1 060	762	27	-	-	-	-	-	-
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	-

Vaccination campaigns are being carried out successfully among peoples in different stages of social development and in areas with extremely poor communications.

1. Objective

The objective is to eradicate smallpox from the country and to ensure that, if smallpox is reintroduced, there will be few, if any, secondary cases.

For practical purposes, smallpox can be considered eradicated from countries where it has been persistently present, after two consecutive years without autochthonous cases being reported, provided that there is a good reporting system in operation.

1.1 The chief means of attaining smallpox eradication is mass vaccination. It is now generally agreed that if 80 per cent. of the population - that is, 80 per cent. of each and every sector of the population - is successfully vaccinated within a time period of five years, smallpox will die out.

1.2 Once eradication has been achieved and while the risk of reimportation of smallpox remains, the population can be protected from outbreaks by one of two methods:

1.2.1 The "ring" vaccination method, which consists of early diagnosis of all imported cases, followed by vaccination, isolation and/or surveillance of contacts and possible contacts. The successful implementation of this method requires the existence of a highly-organized general public health service.

The "ring" vaccination method can be very effective, but its use implies the vaccination of all persons who have been in contact with the patient. Primary vaccination of adolescents and adults has produced in some countries a certain

number of cases of post-vaccinal encephalitis. It must be stressed here that the best prophylactic of post-vaccinal encephalitis is vaccination performed at pre-school age.

1.2.2 Maintenance of a full vaccination state. This method is essential in countries in which medical services and communications are not sufficiently organized to practise the first alternative successfully.

2. Establishment of a smallpox eradication service

The smallpox eradication service should be integrated with the existing structure of public health services. It should be a part of the public health service and its activities co-ordinated with those of other sections. Nevertheless, it should possess individuality from the start and its creation should be publicized as an open proclamation of the country's urgent determination to stamp out a disease the presence of which has hitherto been accepted.

2.1 The vaccination campaign must be directed, or at least co-ordinated, centrally. The first step to be taken, therefore, is to charge specific individuals in medical headquarters, at provincial and country levels, with responsibility for smallpox eradication. If, as is possible, the headquarters' director of the eradication service and the provincial director have additional duties to perform, they must have assistants with ability and energetic personality solely concerned with smallpox eradication. A clear line of command must exist from vaccinator in the field to director in the highest level at medical headquarters, responsible for every aspect of administration; in its absence it is usually found that the needs of a remote field campaign get low priority as compared with those of interests closer at hand.

2.2 In some countries, legislation may have to be introduced. This is liable to be a lengthy process and no time should be lost in initiating it. Smallpox Vaccination. A survey of recent legislation, reprinted by WHO, 1954, from International Digest of Health Legislation, 1954, 5, 221-262, is a useful summary in drafting such legislation. If compulsory vaccination is adopted, minimum provision should include primary vaccination in infancy, vaccination or revaccination

on entering and leaving school and on entering certain occupations (particularly the medical services and armed forces, but probably all public services should be included), and universal vaccination in infected areas.

2.3 The smallpox eradication service's planning must embrace the following items, in addition to the vaccination campaign: health education; isolation of cases and surveillance of contacts; quarantine.

2.4 Health education must include active and effective publicity. It should stress that smallpox kills many and blinds or disfigures many others, but that by vaccination and the early isolation of cases it can be stamped out rapidly. The press and radio are useful vehicles as far as they reach. Beyond and beside them, use should be made of visual methods (posters, etc.), talks in schools, propaganda by mass education and other campaigns, and the influence of teachers, headmen and religious leaders previously won over.

2.5 Isolation of cases.

2.5.1 House isolation should be avoided if possible, though it can be used as a last resort in rural areas. All members of the household are to be vaccinated and put under surveillance, unless it can be proved that they have recently been successfully vaccinated.

2.5.2 It may be desirable to provide additional isolation hospitals. Buildings may be of the cheapest description that provides the essentials of (a) isolation from other buildings, (b) shelter according to climate, (c) easy cleansability, (d) sanitation and water. Any existing masonry-constructed building may be adaptable to serve as a temporary isolation hospital. Alternatively, a temporary isolation hospital may be designed so as to be saleable for some other purpose when the need for it has ended.

2.5.3 Transport of patients to hospital must be allowed for.

2.6 Quarantine services may need to be rendered more efficient. They should be provided with vaccination facilities. There is no doubt that vaccination of travellers from certain areas often has been below acceptable standards.

2.6.1 At long land frontiers it is less expensive and more desirable in every way to encourage international travellers to use main routes by ensuring the minimum of delay and providing facilities. Closed frontiers are invariably traversed by remote paths and if infection is carried along these, it is more costly and difficult to eradicate than if it occurs along main routes.

3. The campaign

Information and planning.

3.1 Information. As much of the following information should be gathered for every district, then consolidated, first for provinces and finally for the whole country:

3.1.1 Census or estimated population.

3.1.2 Statistics relating to smallpox: average annual cases; occurrence as epidemics; vaccination state.

3.1.3 Health services: hospitals, dispensaries, etc.; public health services; clinical and preventive staff; available transport.

3.1.4 Availability of persons outside the regular health services for recruitment as vaccinators, etc. - school-teachers, staff of voluntary agencies, lay civilians with minimal educational qualifications.

3.1.5 Social features: percentage literacy, urban and rural; if rural, villages, isolated hamlets or dwellings; existence of markets or other meeting places; past acceptance (or not) of vaccination; civil leaders as possible propagandists; presence of nomadic or migrant elements; isolated farms.

3.1.6 Geographical features: area; existence of large scale maps; communications; proportion of population accessible by motor transport in dry and wet seasons; ditto by cycle; other forms of transport available (e.g. passenger lorries, animal transport); relation to frontiers or international routes; main urban centres.

3.2 Planning. On the basis of the above information (most of which a reasonably informed M.O.H. should be able to write down out of hand) the campaign is planned.

3.2.1 There are two systems of mass vaccination - house to house, or at collecting points. The latter enables a vaccinator to carry out more vaccinations in a day but generally experience indicates that nowhere near 80 per cent. of the population attends. The house to house method requires a greater effort and more intensive work but ensures a better coverage of the population. In most areas this method must almost certainly be adopted. Whichever method be chosen, it is essential to warn people in advance of the date and time when they will be vaccinated.

It is all important to calculate the average number of vaccinations which one vaccinator can perform annually and daily and in the conditions prevailing locally, since the timing and staffing of the whole campaign depends on this. Experience in various countries indicates that the number may vary greatly: only 7000 a year in one rural area of Africa with individual scattered houses and a long, immobilizing wet season; 22 000 and 15 600 a year respectively in two Middle East countries; 60-80 a day as a general average in South America; and as many as 150-250 a day 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 used, with success, 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 isolated dwellings.

Some countries have the means and the manpower available to recruit as many vaccinators as they wish. Others may lack both funds and persons with the minimum desirable educational qualifications.

3.2.2 The work of vaccinators must be supervised constantly and strictly, by inspectors who, however, must be on sympathetic terms with the men under them. 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. It may be hard to find sufficient men of the calibre and integrity required for inspectors. Experience indicates that usually one inspector can supervise 7-10 vaccinators; the number is as few as four in a particularly scattered rural area.

3.2.3 Medical supervision also is required; there should be a cadre of full-time medical officers of such a number that, at least, any inspector can call out a medical officer reasonably quickly in an emergency.

3.2.4 Geographic, climatic, social, financial and manpower considerations must all be given their due weight in deciding whether to tackle the whole country simultaneously or by concentrating staff and dealing with one area after another. The latter method has given excellent results in the Americas. It has the advantages of allowing the closest supervision, a more exhaustive coverage, and of shortening the lines of communication from the director of the campaign to the staff in the field. In either event, the whole campaign should be timed in detail and should not occupy more than a total of five years.

At the start, time must be allowed for training vaccinators. Countries vary in the length of training they give, but the training need not be long, provided that subsequent supervision is efficient. Collection and training of the cadre of inspectors may take longer. Once the campaign has started, these can be selected from the more efficient and reliable vaccinators.

3.3 Cost. In working out the budget of a vaccination campaign, 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:

3.3.1 Vaccine. It can either be produced in a country's own laboratories or bought from other countries. Costs per unit vary from US\$ 0.0049-0.067 for dried vaccine and US\$ 0.002-0.017 for glycerinated lymph.

3.3.2 Vaccination. The average cost per vaccination varies from US\$ 0.03-0.118 according to the employment conditions in the different countries. Vaccinators' conditions of service vary and, as usual, those in permanent employment draw lower wages than those on short-term contracts.

3.3.3 Transport.

3.3.3.1 In many countries the bicycle is the ideal transport for vaccinators. It has been found most satisfactory, in some established field medical services, to pay junior staff fairly generous allowances for maintaining their own cycles.

3.3.3.2 The motor cycle has usually been found to be an unsatisfactory and dangerous form of official transport.

3.3.3.3 Provision must be made for staff to use other available means of transport; buses, animal transport, river transport, etc.

3.3.3.4 There are obvious advantages in providing jeep or other motor transport for as many supervisors as possible, especially when they have to work in rural areas. They are thus enabled to supervise more vaccinators and distribute the vaccine quickly. The availability of motor transport facilitates the daily distribution from a central base of vaccination teams to their place of work. In cities or densely-populated areas, supervisors may be able to do their work with bicycle transport.

3.3.3.5 Maintenance and depreciation of transport must be allowed for.

3.3.4 Miscellaneous items

3.3.4.1 Some form of uniform, even if only a badge or brassard, should be provided for staff.

3.3.4.2 Stationery.

3.3.4.3 Containers for transport of vaccine. When lymph vaccine is used, thermos containers are essential.

3.3.4.4 Vaccination materials and equipment.

3.3.4.5 Refrigerators for distribution centres. These are essential when lymph vaccine is used, and highly convenient when dried vaccine is employed.

3.3.4.6 In some areas it may be necessary to rent buildings as local stores, etc.

3.3.5 The increased cost of raising the efficiency of case isolation and quarantine services must be allowed for.

3.3.6 Provision should be made to ensure good reporting of new smallpox cases, especially in the vaccinated areas, as well as possible complications of vaccination.

3.3.7 It must not be forgotten that after the initial eradication campaign is finished, it still will be necessary to make provision for the maintenance of an adequate level of immunity of the population in following years.

4. Execution of the plan

4.1 An efficient administrative organization must be established and based on appropriate financing. It embraces supply of vaccine and other stores, transport, statistics and maps, propaganda, training and staff welfare. These items are all sufficiently obvious, except perhaps the last. The life of a field worker in a backward area is a hard one, and experience in established field medical services emphasizes that his efficiency varies with his morale. Usually, little can be done to provide comforts, which in fact are not expected. The main factors contributing to a high morale are: (a) administration on as personal a level as possible; (b) adequate salary scales; (c) absolute regularity in the dates of pay, on which the credit and therefore the daily bread of mobile field workers depend; financially, the third of next month is very different from the thirtieth of this month; (d) the status given to the job. Some sort of uniform, if only a brassard, should be provided, and the judicious use of publicity helps.

4.2 The directing cadre must be drawn from the country's own nationals, though the assistance of short-term consultants can be requested from WHO. The directing team must take full responsibility for administration, but they should avoid getting too much tied down by routine detail. A considerable part of their time should be spent in the field.

4.3 In recruiting inspectors, the following qualities must be considered:

4.3.1 Intelligence: sufficient to grasp the principles underlying the campaign and the technical procedures involved.

- 4.3.2 Literacy: sufficient to complete return forms accurately, keep a simple stores' ledger, read a map, etc.
- 4.3.3 Integrity: although there is no black market value attached to vaccine and vaccination (as there is, for example, with antibiotics), every supervisory activity lends itself to the establishment of some form of racketeering.
- 4.3.4 Initiative: sufficient to cope with unexpected situations.
- 4.3.5 Reliability and diligence.
- 4.3.6 Physical constitution: physical fitness adequate for a life of continuous and arduous activity.
- 4.3.7 Ability to drive and maintain a motor vehicle. The pay of a driver-mechanic probably equals that of an inspector. Supervision, distribution of vaccine, etc., will be much less costly if supervisory staff can drive themselves competently. It takes longer to train an intelligent man to drive than to vaccinate and diagnose smallpox and, therefore, the former ability may well be more valuable in a recruit than previous knowledge of smallpox. Successful use of this principle was made in the yaws campaign in at least one country.
- 4.3.8 Health inspectors and public health nurses with the above qualifications make good inspectors. In some countries, ex-military N.C.O.s have proved to be excellent inspectors of field medical work.
- 4.3.9 It should be borne in mind that good conditions of service, with emphasis on prospects rather than pay, will be required in order to attract the type of men desired as inspectors.
- 4.4 The training of inspectors.

The period of training will vary with previous experience. The requirements are: (i) theoretical and practical instruction in the epidemiology and diagnosis of smallpox, disposal of cases, surveillance of contacts, vaccination; (ii) instruction in looking after stores, rendering returns, reading and making maps; (iii) perhaps instruction in driving and maintenance of motor transport.

The importance of public relations must be stressed throughout the training course.

4.5 In recruiting vaccinators, the following qualities must be considered:

4.5.1 Intelligence: sufficient to understand fully the technique of vaccination, its contra-indications, and to answer laymen's questions about it; to grasp and carry out instructions.

4.5.2 Literacy: sufficient to read and write, and to fill up a simple form. Intelligence and literacy are separate qualities and the latter must not be taken as a reliable measure of the former. Intelligent illiterates are quite capable of performing the duties of vaccinators, except that their inability to complete returns of the day's work is an administrative nuisance.

4.5.3 Physical constitution: physical fitness adequate for a life of continuous and arduous activity.

4.5.4 Freedom from excessive family ties: on this and other grounds it is advisable to recruit young men.

4.5.5 Sex: in some countries it may be necessary to employ female as well as male vaccinators.

4.6 The future of the personnel.

Once eradication is achieved, although a close surveillance should be maintained, a reduction in force will be possible. The released personnel should be transferred to other public health activities, taking advantage of the public health experience gained during the campaign.

4.7 The training of vaccinators.

Some countries train vaccinators for as long as six months. This is excessive. The training programme covers only the subjects mentioned in 4.5.1 and 4.5.2, most of which can be learned in two or three weeks of in-service training, perhaps in selected areas under inspectors with a flair for instruction.

5. Organization. Detail

Provincial directors allot districts to medical officers or their equivalents. Medical officers allot areas to inspectors, giving them overall timetables and ensuring that their supply and return administrative channels are fully understood. Inspectors give vaccinators detailed programmes (by the day or week according to circumstances), supplying them at the same time with the necessary equipment and vaccine. At each level there must be full discussion embracing population, transport, etc.

5.1 The inspectors' duties thereafter are as follows:

5.1.1 To give the people concerned advance warning of the date and time when they will be vaccinated.

5.1.2 To ensure that the vaccinators are keeping to their programmes, by frequent unannounced visits.

5.1.3 To discuss and assist with any difficulties encountered by vaccinators.

It is the inspectors' responsibility to hire local transport for vaccinators when necessary. For this purpose, they may need to keep small imprest accounts. (An imprest account is a sum of money, in ready cash, drawn from a specified vote and held by an individual for the period of a financial year. The vote concerned may be a wide one with a label such as "contingencies", or perhaps a transport and travelling vote. Cash disbursements from the imprest are written down in an imprest account book and recouped in due course from the vote by means of regular vouchers. An imprest may be of any size and the imprest holder may give out sub-imprest from it. In a vaccination campaign, for example, a district medical officer might hold an imprest of US\$ 500, much of which would be out in sub-imprests of US\$ 10 to US\$ 20, according to circumstances, held by inspectors.)

5.1.4 To check the results of a certain percentage of primary vaccinations carried out by each vaccinator under him.

5.1.5 To receive vaccinators' returns of work, consolidate them weekly and pass them on to the medical officers.

5.1.6 To notify any case of smallpox and take first steps over isolation, vaccination and surveillance of contacts.

5.1.7 To act as a vaccinator whenever necessary.

5.3.2 Certificate of vaccination of a house. In some countries the inspector or vaccinator sticks such a certificate, including remarks on absentees, etc., on the door. It is a legal offence to remove or deface the certificate.

5.3.3 Individual vaccination certificates. These are given in some countries. In many countries, probably they will not be considered necessary.

6. Vaccination

6.1 Freeze-dried vaccine is recommended for all tropical and subtropical rural areas, with poor communications. It is issued in containers of 100, 50, 25 or 10 doses and it remains potent only for two or three hours after reconstitution, depending on the temperature to which it is exposed, and therefore there may be wastage of some doses.

6.2 For areas with good communications and with refrigerated storage available, glycerinated lymph has many advantages. This type of vaccine should be maintained, when stored for long periods, in a freezer at temperatures of -10° to -20° . When delivered to the field and for periods of up to 15 days, it can be kept in the refrigerator at $+4^{\circ}\text{C}$.

6.3 A good vaccination technique must be used and the multiple pressure method of vaccination is recommended. No difficulty has been experienced in teaching it to vaccinators. Whatever method be used, a sharp needle makes a good vaccination lancet. The advantage of using needles, rather than more elaborate lancets, is that each vaccinator can be issued with sufficient sterilized needles for up to a week's work, using a fresh one for each vaccination. The number used acts as a check on the number of vaccinations performed.

7. Co-ordination with other campaigns

In many countries, campaigns against certain specific diseases, involving contact with every individual in the population, are already in progress. The idea of combining vaccination with any of these is an obvious one. The reservation must be made, however, that the component operations of a combined campaign must

fit together in their timing: e.g. if in one operation 500 persons a day are dealt with, and in another only 100 to 200, the two will not combine.

Vaccination has been combined very satisfactorily with yaws campaigns in some countries.

Co-ordination with other campaigns is especially indicated for maintenance of a good level of immunity in the population after eradication in a country or an area has been achieved.

8. Evaluation

The success of the campaign will be indicated by the disappearance of the disease. The percentage of the population covered in each area will give a clear indication of the thoroughness of the work carried out. A check of the technical accuracy with which the vaccinators are administering the vaccine, as well as of the potency of the vaccine in the field, will be made by observing the vaccination reactions in a representative sample of the persons receiving primary vaccination.

The consolidated information prepared weekly by the inspectors, after being examined and further consolidated if necessary by the medical officers, should be received at headquarters without much delay. The headquarters' office should process this information monthly and produce monthly reports on the progress of the campaign. These monthly reports should appear not later than the second week of the following month and should contain the information indicated in the proforma illustrated below:

Summary of the work carried out by the smallpox eradication campaign during the month of

1	2	3	4	5	6	7	8	9
Major political subdivisions	Estimated population	Total No. of vaccinations	% population vaccinated $\frac{3}{2} \times 100$	No. primary vaccinations	No. of revaccinations	No. primary vaccinations controlled	No. positive primary vaccinations	% positive primary vaccinations $\frac{8}{7} \times 100$

A similar table with cumulative results for the year should also be prepared.