

ASSESSMENT

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ASSESSMENT of the Vaccination Programme

1. Introduction

In the smallpox programme there is one objective - eradication of smallpox. The success of the programme, therefore, is appraised ultimately by the occurrence or absence of endemic smallpox and the principal assessment technique, accordingly, is surveillance (Section VII).

It is recognized, however, that to achieve smallpox eradication, some substantial proportion of the population must be rendered immune through successful vaccination. Techniques are needed to assess the progress being made in the programme with respect to (1) the proportion of people to whom vaccine has been administered and (2) the proportion who have experienced "successful takes". Both aspects are important. In a number of countries, for example, numerous "vaccinations" are recorded annually but the vaccine is of such poor quality that few experience takes; on the other hand, potent vaccine is of limited value unless widely applied.

In considering this phase of the programme, it is well to keep in mind that certain areas of the country and certain populations are clearly of greater importance than others so far as smallpox transmission is concerned and thus also of greater importance with respect to assessment. As previously noted, the probability of disease transmission is highest in the most densely crowded areas. In these areas a higher proportion of the population will need to be vaccinated than in more sparsely settled parts of the country. Accordingly, assessment in such areas deserves greater attention.

In this section, methods for the collection of three general types of data are described:

- (a) Tabulation of numbers of vaccinations performed by district, sector, etc. and by time period (Part 2).
- (b) Proportion of vaccinations performed which resulted in successful takes (Part 3).
- (c) Proportionate vaccination coverage in various areas and parts of the country (Part 4).

2. Tabulation of numbers of vaccinations performed

The purpose of tabulation of the numbers of vaccinations performed is:

- (a) to measure the work output of vaccinators and teams and to provide team supervisors and national authorities with a continuous monitoring of their productivity;
- (b) to provide working teams with rough estimates of coverage obtained relative to the "target population" for a given site or area;
- (c) to determine approximate coverage of specific population segments.

Although tabulation of vaccinations is an ^{essential} important component of every programme, it must be complemented by other techniques of assessment. ~~A simple~~ ^{Howev} tabulation of vaccinations performed does not provide adequate information as to the actual proportion of the population vaccinated nor the success of the vaccination. The fallacy in relying simply on a count of vaccinations may be exemplified in two programmes. In one, so many vaccinations were carried out that it was calculated that "140 per cent. of the population had been vaccinated". Subsequent surveys revealed, however, that only 70 per cent. of the people had, in fact, been vaccinated and that schoolchildren and certain other accessible groups were being vaccinated every six months. In another programme, vaccination of almost one-third of the population was recorded annually. After several years of failure to eradicate smallpox, vaccination take rates were checked and found to be virtually nil; the vaccine in use was not potent.

2.1 Mobile teams or house-to-house vaccinators employing a tally sheet

2.1.1 Introduction

The simplest and most rapid device for enumeration is a "tally sheet". At the time of vaccination, a mark is made on a sheet denoting that a person of a given age-group has been given primary vaccination or has been revaccinated (Annex I). Information with respect to the relative proportion of primary vaccinees and revaccinees has generally been found to be of value since vaccinators commonly find it easiest to reach those who have previously presented themselves for vaccination whereas the emphasis should be on reaching those never previously vaccinated. Having made some estimate of the "target population" to be vaccinated, the vaccination team, while still at the site, can determine the approximate extent of coverage and may also ascertain whether there is a deficiency in representation of one group or another, e.g. schoolchildren, adults who may be working in the fields or who may be engaged in marketing activities, etc. While still at the site, special efforts can be made to reach what appear to be deficiently represented groups.

2.1.2 Estimate of "target population"

To obtain an estimate of the "target population" in a given area may be difficult. Census data are often inaccurate; migration particularly into urban areas occurs at a rapid, often variable, rate; in a programme using the "collecting point" type programme, variable numbers of persons may be attracted from outside the immediate target population area.

There is no simple method for obtaining accurate population estimates by area. Where malaria programmes are operative, current population data can usually be quickly obtained. Occasionally, estimates will have been developed for use in other types of health or development programmes. Where no such data are available, census figures appropriately corrected for subsequent population growth and/or informed local opinion may be all that is available.

In one approach, used successfully in several programmes, an enumerator precedes the vaccination team and, by systematic house-to-house visits, records the number of persons resident in each house. As previously described, he may also number the houses in sequential order and, with a second number, indicate

the number of residents (e.g. 1/4, 2/6, 3/1, 4/2, indicating four residents in the first house, six in the second, etc.). A house-to-house vaccination group normally follows the enumerator, moving through the village in the same pattern, knowing with reasonable certainty the target population to be vaccinated. For a "collecting point" type programme, an estimate of the target population might similarly be obtained.

Whatever the circumstance, a "best estimate" of population by sector, area, etc. should first be developed both from the standpoint of operations and assessment.

2.1.3 Information to be recorded

Tally sheets for the notation of information must be as simple as possible to permit rapid recording. Useful data, however, can be obtained while retaining the feature of simplicity. A record of vaccination by age-groups is helpful to ascertain, at least crudely, the approximate coverage of pre-school children, school-age children, and adults. Recognizing that exact ages are not commonly known, the age groupings should be sufficiently broad to permit recorders to estimate ages where necessary. Age-groups suggested for use are: under 5 years, 5 to 14 years, 15 years and older.

A further subdivision to permit recording of those receiving primary vaccination and those receiving revaccination has been found most useful in many programmes to determine whether the vaccination programme is simply reaching the most accessible portion of the population or whether previously unvaccinated persons are being contacted (Annex I). The fact of previous vaccination is usually ascertained by the visual evidence of a primary scar. Some time, however, is required to examine the arms of the individual in order to make this determination and, in some programmes, it may not prove logistically feasible to collect this information.

Alternatively, the sex of the vaccinee may be recorded in addition to age. This will be useful to ascertain the relative extent of coverage of possibly difficult-to-reach groups, for example, working males, women in Moslem countries, etc.

Although it would be ideal to obtain information by age-group and sex and vaccination status, the recording of all three variables in any simple manner is virtually impossible. With three age-groups, two categories by sex and two by vaccination status, it would mean classification of each individual into one of 12 different groups. This is not practicable if the features of rapidity and simplicity with respect to the tally sheet are to be retained.

2.1.4 Operations

The recorder with a team or the house-to-house vaccinator (if working alone) should be responsible for maintenance of the tally sheet and, in general, for providing a total by page (Annex I). Individual pages may then be reviewed by the team leader and entered on a summary sheet (Annex II). As a check on vaccine supplies a system may be established whereby the team leader counts the number of vials of vaccine used each week and enters this figure in the weekly summary sheet. The quantity of vaccine used may then be contrasted to the number of vaccinations performed.

As a next step the team supervisor might check and sign the summary sheets, record the vaccinations performed on a working map and send the summary sheets at appropriate intervals, perhaps every two to four weeks, to the national or intermediate level headquarters.

2.2 House-to-house vaccination employing household and village register system

In some programmes employing house-to-house vaccination, a record has been made on a so-called "household roster" of all persons living in a house and those vaccinated have been so recorded. Individual rosters for a village or an area of a town have generally been retained at the local health post or administrative centre for use in follow-up vaccination. By this device, an enumeration of all persons resident in the village or area is obtained and data regarding extent of theoretical coverage should be immediately available.

Although superficially this system appears ideal, it has proved to be virtually unworkable in practice¹. Aside from the fact that the recording of all names in this manner is a highly time-consuming operation, it has proved practically impossible to keep such records up to date, complete, and/or accurate, especially in developing countries. Migrants have proved impossible to deal with under this system. Comparatively few vaccinators have been found sufficiently conscientious or diligent to provide consistently complete and usable records. With this system, it has unfortunately been considered unnecessary to have any form of independent assessment of vaccination coverage (described in Part 4) except on an occasional basis. The very large numbers of staff required for execution of this type of programme has commonly forced a reliance on low quality personnel. Fraudulent reports have been common and with no mechanism for independent assessment, reported results of large numbers of vaccinations performed has led responsible national authorities to believe that the programme was proceeding well when, in fact, it was foundering. Only under unusual circumstances with highly disciplined populations, a large complement of reliable vaccinators and excellent supervision, should this system be considered.

A possible variant of this system which has been successfully used in some areas is to affix the household roster and record of vaccinations to the wall of the house. Although still requiring large numbers of staff, the vaccination record for a given house may, at least, be readily found and, if none is present, vaccination may again be carried out. If fraudulent marking of the roster can be avoided and if this approach is acceptable to the villager, a follow-up assessment of vaccination coverage can easily be carried out by house-to-house canvass. Vaccinators, in the course of vaccination, will need to record vaccination totals on a separate summary sheet to provide daily and weekly tallies for programme purposes.

2.3 A modified household roster

A simplification of the "household roster" approach noted in Part 2.2 may be achieved by omitting the detailed information with respect to specific name and sex of each inhabitant. Under this system, the enumerator might record on a house-by-house basis house number, name of head of household, and number of persons in each of the three broad age-groups noted (under 5 years, 5 to 14 years, 15 years and older). Vaccinators in a house-to-house programme might then record the numbers of persons in each age-group vaccinated. The records would also be available for the assessment team.

It is well to note, however, that neither this system nor any other system has, in practice, proved effective and workable as a permanent record of the vaccination status of individuals in a population. The "modified household roster" noted here, like the detailed family register described in 2.2, should be considered only as a technique of tabulation and recording which is of value only for the several-week period during which systematic vaccination and evaluation is carried out. The constant movement of populations in and out of an area, the continuing addition of newborns and deletion of persons by death makes it quite impossible with respect to individuals to maintain a reasonably accurate household register on a continuing and permanent basis.

2.4 Reports to WHO

To facilitate regional and international co-ordination of the programme, WHO requests that information as to numbers of vaccinations or revaccinations performed be submitted every three months in two copies to the WHO Regional Office. The suggested form is shown in Annex III.

3. Field evaluation of success of vaccination

A continuing assessment of vaccination take rates is necessary to assure that the vaccine in use is potent and that vaccinator technique is adequate to assure a high proportion of takes.

As pointed out in Section III, Technical Considerations, the probability of a "major reaction" following vaccination depends in major part upon the individual's past vaccination history. In one area, "major reactions" might be observed in 60 per cent. of revaccinees and, in another area, in 90 per cent., despite fully potent vaccine and good vaccination technique in both areas. Additionally, experience has shown that the reading of "major reactions" is subject to considerable interpretive error when the reactions are not particularly marked. Thus, a variation of 20 per cent. or more among individuals reading the reactions would not be unexpected. It is, therefore, most difficult to know from results obtained in a given area whether a satisfactory response is being obtained or not.

Response to primary vaccination, on the other hand, is a very definite "all or none" type response subject to little error in interpretation. With good technique and a fully potent vaccine, 95 per cent. or more of those vaccinated should respond with a take. If this proportion of individuals responds with a primary take, it is ~~reasonably certain~~ that a satisfactory proportion of revaccinees will also have responded. Practical considerations thus dictate the evaluation of primary take rates as the best assessment under field conditions of vaccine potency and vaccinator technique.

Since the primary response evolves over a more extended period, evaluation of primary responses may be carried out at any time between seven and 21 days following vaccination. This, of course, permits a greater flexibility with respect to timing in field operations. Also, those receiving primary vaccination will normally be represented principally by children, especially pre-school children. Those under the age of five are more likely to be found in or near home, making assessment easier and more practical.

In summary, then, for the continuing assessment of vaccine potency and vaccinator technique, it is proposed that primary vaccinations among pre-school children be examined at some period between seven and 21 days following vaccination.

Provision should be made for assessing results obtained by each vaccinator and vaccinating team on a continuing basis. The evaluation of success of vaccination will normally be combined with an appraisal of vaccination coverage as described in Part 4.

4. Evaluation of extent of coverage

4.1 Introduction

To determine the extent of vaccination coverage requires a method enumerating with reasonable accuracy the number of persons resident in a village, town or area and the number who were vaccinated. As described in Part 3, an evaluation of the proportion of pre-school children who develop successful primary takes will normally be combined with this appraisal as continuing assessment of vaccine efficacy and vaccinator technique.

The use of trained, independent assessment teams not involved in day-to-day vaccination provides greater certainty that the data obtained have been objectively gathered and are of reasonable accuracy. Knowledge on the part of the vaccination teams that their work is constantly being checked, and perhaps compared with the work of other teams, serves a motivating function, and, indirectly, a disciplinary role.

Several approaches might be considered with respect to evaluation of vaccination coverage and vaccination take rates. The methods will vary according to the system employed for the systematic vaccination coverage (i.e. house-to-house or collection point system) and particular circumstances with respect to the area and quantity and type of personnel available. Whatever the type of programme, the important principle is to establish a programme of continuing evaluation of coverage and vaccination take rates by an assessment agent (or team) who is administratively independent of the vaccination team.

4.2 Total population assessment

In many programmes, an assessment/mopping-up team of one or two individuals has been constituted with the responsibility to visit systematically on a house-to-house basis each area where the vaccinators have passed. This team, visiting each area seven to 21 days after the vaccination group, is normally required: (1) to determine the proportion of persons who have been vaccinated; (2) to determine the vaccination take rates; and (3) to vaccinate individuals who were missed during the systematic programme. This system could be employed both in the instance of a house-to-house vaccination programme and in the instance of a collecting point type programme.

To determine the proportion of persons vaccinated, a simple query may be sufficient in many areas. An alternate approach would require that each person, at the time of vaccination, have his finger marked with a dye such as silver nitrate, which would persist until the assessment team visited ^{2,3}. This would provide more certain evidence that he had presented himself for vaccination. [In many areas,

surveillance has demonstrated that 80 to 95 per cent. of cases are occurring among individuals who have never previously been vaccinated, i.e. who do not have primary scars. ~~Assessment might be focused in these areas of the population who do or do not have a primary vaccination scar.~~

As noted before, vaccination take rates are best determined among pre-school children undergoing primary vaccination.

Vaccination of individuals missed during the initial systematic phase should be carried out, particularly of individuals who do not evidence a clear primary scar.

4.3 Assessment of a sample of the population

Assessment of a sample of the population, rather than the total population, may be employed. Such a system requiring that a sample of perhaps 10 to 25 per cent. of the population be contacted as part of the continuing programme of assessment can effect a considerable saving in manpower. However, since a more sophisticated plan and approach is required, a higher quality of ~~staff~~ ^{and less numerous} staff is needed who will have to be trained in sampling techniques.

The sample survey approach for assessment of the smallpox programme is being tested in several areas but is not yet in routine use in any. A tentative proposal only is described below.

4.3.1 General considerations

Experience indicates that a team of about four to six persons is most practicable. Each team member should be able to interview 50 to 70 households per day, depending on area and circumstances.

The survey might, as in the total assessment situation, determine persons vaccinated either by interview and query or by examining individuals who had previously been marked with a dye at the time of vaccination (see previous). Alternatively, as noted previously, a determination might be made with respect to the proportions of persons at different ages with a primary vaccination scar.

4.3.2 The technique of cluster sampling

The "cluster sampling" method is probably the easiest type of sample survey to implement. It has been used successfully in many developing countries. For example, in Ethiopia (Addis Ababa) it was used to establish baseline data for evaluating the effectiveness of the work done by the National Tuberculosis Centre⁴; in Ghana, a survey of the population and budgets of cocoa-producing families was carried out⁵; in Gabon, a sampling technique was used to collect income and expenditure patterns of rural families⁶; in Nigeria, a nation-wide economic survey covering the entire rural area was conducted⁷. Other useful references with respect to cluster sampling are provided⁸⁻¹⁴.

4.3.3 The household as the unit of enumeration¹⁵

For the purposes of the smallpox programme, the individual "household" would appear to be the preferred unit for the collection of data.

The internationally adopted definition (for census purposes) of private households recognizes a household as one or more persons who occupy the whole or part of a housing unit and who provide themselves with food or other essentials for living. The general criteria for identifying members of a household are common housekeeping arrangements, a sharing of the principal meals in the sense that the household's food supply is obtained for common consumption, and in having common arrangements for supplying basic living needs.

The "extended" family, dispersed in a colony of housing units, and the several potentially separate family units which result from polygamous unions, present a problem in some areas since the definition of a household nominally specifies occupancy of the same housing unit. Assuming that the members share the principal meals and generally are regarded as one unit, the various "housing units" may simply be considered as separate sleeping quarters. If, on the other hand, the various member groups also eat separately, they may be considered as separate households for enumeration purposes.

4.3.4 Sample size

Without more detailed knowledge of household patterns and size of households, it is difficult to forecast the size of sample needed under varying situations. Some estimates are presented here for preliminary guidance. In general, they are conservative in that they propose a sample probably somewhat larger than may actually be required. If these sample sizes are employed, there is reasonably good likelihood they will be large enough for assessment purposes.

Five different sampling situations are considered:

- (a) villages and towns under 5000 population;
- (b) towns and cities from 5000 to 100 000 population;
- (c) cities with over 100 000 population;
- (d) villages and towns with no readily definable separate housing units;
- (e) over-all survey of a rural area.

(a) Villages and towns under 5000 population. Assuming an average household unit size of five (which may be an underestimate), a population in which 20 per cent. of the population is less than five years of age, and a desire to estimate the extent of vaccination coverage within ± 10 per cent. (with 95 per cent. certainty) for each of three age-groups (under 5 years, 5 to 14 years, 15 years and older), calculations have been made to estimate the approximate sample size requisite for different-sized villages and towns.

The various-sized villages and towns can be grouped into five sampling categories as shown below:

<u>Size of Village or Town</u>			
<u>Estimated Population</u>	<u>Estimated No. of Housing Units</u>	<u>Sample</u>	<u>Possible Sample Size (No. of Housing Units)</u>
5 - 999	1 - 200	All houses	1 - 200
1 000 - 1 999	200 - 400	Half of all houses	100 - 200
2 000 - 2 999	400 - 600	One-third of all houses	133 - 200
3 000 - 3 999	600 - 800	One-fourth of all houses	150 - 200
4 000 - 4 999	800 - 1 000	One-fifth of all houses	160 - 200

In principle, a simplified method to be employed in selecting the housing units for survey might be the following. If, for example, one-fifth of the housing units are to be sampled, the interviewer is instructed to count the dwelling unit at either end of the village or town as housing unit No. 1 and interview at every fifth house. If a malaria programme is operative in the area, all the houses may have been numbered; in which case, the interviewer could visit homes numbered 1, 6, 11, 16, etc.

In the unplanned community where there is no malaria programme, selection of every fifth house, for example, may be most difficult and compromise may be required. By visual observation, clusters of five (or any other number) houses might be identified, and, in a consistent manner, one unit (or an appropriate number of units) selected for inclusion in the sample.

(b) Towns and cities from 5000 to 100 000 population. A minimum sample of 200 housing units is necessary for towns and cities with 5000 to 100 000 persons. In this situation, the block or some area similar to a block should be the primary sampling unit rather than the housing unit.

Using the best available map, the town or city should be divided into segments containing about 25 to 30 households. Each segment should be numbered and a random sample of 30 such segments selected. Within each of the selected segments, interviews should be conducted at every fourth house. Thus, in each segment, seven households would be checked. If done in 30 segments, 210 household interviews in all would be carried out.

(c) Cities over 100 000 population. Cities of this size present special problems in size, socio-economic differences, etc. Therefore it is recommended they be surveyed only with the consultation, assistance and guidance of a consultant statistician.

(d) Villages and towns with no readily separable housing units. In areas where large compounds prevail, with a large number of persons gravitating about the person of the family head, separate housing units may be difficult to define. If the number of compounds can be determined along with an estimate of the total population, the requisite number of compounds to be sampled can be calculated. For example, if there is a village with 40 compounds and an estimated population of 2000, the average compound population would be 50. Assuming that approximately 20 per cent. of the population is under five years of age, 10 children under five years of age are to be expected in each compound. A sample which includes 200 children under five years of age should yield the requisite number of persons in all age-groups. Thus, to include 200 children under age five in the survey, 20 of the 40 compounds would need to be sampled, and so forth.

Under some circumstances, it may prove difficult or impossible to determine alternate households for the purposes of interview. In large parts of the savannah-sahara area of Africa, for example, villages sometimes assume the form of continuous walls with occasional doors or windows but no distinctive household unit separation is visibly evident. In such a situation, if there are several segments or sections of such a village, a total survey of all residents in randomly selected segments might be undertaken with the hope that the rather gross segments selected were reasonably representative of the experience of the village as a whole.

(e) Over-all survey of a rural area. An over-all survey of a rural area is reasonably complex and requires careful planning and scheduling if it is to be carried out. An illustration of how this might be done is outlined below for hypothetical Medical District X with a population of 193 500 persons grouped in villages and towns as follows:

<u>Population</u>	<u>No. of Villages</u>	<u>Total Population</u>
<5 000	216	151 000
5 000+	2	42 500

The two towns of greater than 5000 population also represent the only market centres in this area. If it has been decided in this country that all towns of greater than 5000 population should be surveyed as well as all market centres, an assessment survey of these two towns, as outlined previously, plus a sample of the rural village area would be indicated.

To obtain an estimate of coverage in the rural area, a random sample of 30 of the 216 villages or towns with less than 5000 population would be required for assessment. Selection of the 30 villages should be based on the approach of "probability proportional to population".

To select 30 villages with probability proportional to population, the following table might be set up:

<u>Village No.</u>	<u>Estimated Population</u>	<u>Population (Hundreds)</u>	<u>Cumulative Population (Hundreds)</u>
1	282	3	3
2	716	7	10
3	384	4	14
4	258	3	17
5	461	5	22
6	158	2	24
7	4 292	43	67
8	140	1	68
9	755	8	76
10	225	2	78
11	417	4	82
12	514	5	87

<u>Village No.</u>	<u>Estimated Population</u>	<u>Population (Hundreds)</u>	<u>Cumulative Population (Hundreds)</u>
13	967	10	97
14	883	9	106
<u>15</u>	392	4	110
<u>16</u>	220	2	112
17	489	5	117
<u>18</u>	504	5	122
19	581	6	128
<u>20</u>	1 204	12	140
.	.	.	.
.	.	.	.
.	.	.	.
216	131	1	1 510

Thirty numbers between 0001 and 1510 from a table of random numbers (Annex IV) should next be selected. Assume that six of the 30 random numbers selected were 68, 80, 108, 112, 121, and 138; it is to be noted that 68 falls in village No. 8, 80 falls in village No. 11, etc. (any number between 79 and 82 would fall in village No. 11). In this manner 30 villages would be randomly selected. Having completed the selection of villages, a table as follows may be set up:

<u>Village No.</u>	<u>Estimated Population</u>	<u>Estimated No. of Housing Units (5/h.u.)</u>	<u>Sampling Ratio</u>	<u>Estimated No. of household Units in Sample</u>	<u>Approximate Assessor Days Required*</u>
39	827	165	1:1	165	2.5
185	217	43	1:1	43	0.5
69	483	96	1:1	96	1.5
21	52	10	1:1	10	0.5
30	164	33	1:1	33	0.5
84	251	50	1:1	50	1.0
31	2 924	585	1:3	195	3.0
37	557	111	1:1	111	1.5
18	504	101	1:1	101	1.5
25	415	83	1:1	83	1.0
45	769	154	1:1	154	2.0
71	3 887	777	1:4	194	3.0
131	984	197	1:1	197	3.0
107	565	113	1:1	113	1.5
8	140	28	1:1	28	0.5
16	220	44	1:1	44	0.5
15	392	78	1:1	78	1.0
61	384	77	1:1	77	1.0
176	555	111	1:1	111	1.5
20	1 204	241	1:2	121	1.5
11	417	83	1:1	83	1.0

* Assuming an assessor can reach 70 household units each day and assuming the need for at least one-half day in each village (rounded off to nearest half day).

<u>Village No.</u>	<u>Estimated Population</u>	<u>Estimated No. of Housing Units (5/h.u.)</u>	<u>Sampling Ratio</u>	<u>Estimated No. of Household Units in Sample</u>	<u>Approximate Assessor Days Required *</u>
112	345	69	1:1	69	1.0
46	158	32	1:1	32	0.5
68	504	101	1:1	101	1.5
82	4 480	896	1:5	179	2.5
26	1 099	210	1:2	105	1.5
104	140	28	1:1	28	0.5
28	132	26	1:1	26	0.5
191	79	16	1:1	16	0.5
70	802	160	1:1	160	2.5
Total	23 650				41.0

* Assuming an assessor can reach 70 household units each day and assuming the need for at least one half day in each village (rounded off to nearest half day).

Approximately 41 assessor days would be needed. Using this scheme, estimates for vaccination coverage and take rates can be determined for each village and estimates for the entire rural area as a whole.

Assessment surveys should be done one to two weeks following vaccination to determine vaccination take rates. Thus the schedule of vaccination centres should be known in advance. When any of the 30 villages selected for assessment are scheduled for vaccination or are included in an area to be covered by a scheduled vaccination centre, that village could then be scheduled for assessment seven to 14 days later. It should be pointed out, however, that the vaccination teams should not know the 30 villages selected for assessment.

4.3.5 Assessment forms

A sample survey form for assessment of vaccination coverage and vaccination take rates in 0-4 year old children is shown in Annex V. Once the villages in any given geographic area are selected for assessment, the information at the upper portion of the form can be filled in listing the village or town, medical district (or circumference, etc.), estimated population and estimated number of households. A survey in a given village should be scheduled about seven to 14 days following vaccination. Based on the estimated population, the sampling ratio can be determined (as previously described). For example, if the village to be surveyed had an estimated population of 1500 persons, the assessor should sample every second house in the village. If the population estimate is fairly accurate (and assuming about five persons per household), around 150 households would be sampled in this village. The form might read, "Begin survey with house No. 1 and visit every second house". After similar forms have been prepared for each town or village in the current block of work, they would be given to assessors assigned to each, together with the date(s) they are scheduled to assess each village. For the village with an estimated 1500 persons, approximately two days would be required to complete a survey and two dates would have been entered in the appropriate space on the survey form.

When the assessor visits a household he should first determine how many children there are under five years of age in the household. He should mark down the number of these children in the first column under "0-4 years of age". He should then determine how many were vaccinated (the number of children with silver nitrate on their finger) and enter the number with silver nitrate stained fingers in the "number vaccinated" column. For children under five years of age, the assessor should then inspect the children to determine how many have no previous vaccination scar and thus are primary vaccinees. This number should be recorded in the third column. He should then determine how many of these had primary takes. Therefore, for those under five years of age, the assessor would be listing the number in the house, the number vaccinated, the number vaccinated for the first time (no scars), and the number of those with a "primary take". He would then determine how many persons there are from 5 to 14 years of age, and 15+ years of age in the household. For these older persons the assessor would only have to determine the number in the household and the number vaccinated.

Not all members of the household will be present at the time the assessor visits. Since it will not be possible to revisit households, nor to search for missing members in order to examine them, some dependence upon history will be necessary. It is reasonable to accept the statement of a responsible member of the household as to the number of persons living there (first column in each age-group) and the number vaccinated. It should not be permissible, however, to accept historical information about vaccination "takes". For children 0-4 years of age, therefore, it will be necessary also to record the number vaccinated who were actually observed and inspected by the assessor, and, of them, the number observed with "takes".

Each line on the form represents a household. The assessor is able to list the information for 30 households on the first page of the survey form for any given village. He should then utilize continuation sheets.

5. Utilization of data obtained

Criteria should be established prior to the inception of the sample survey as to what proportion of coverage is acceptable, in other words, below what level of coverage or of vaccination takes it would be necessary to revaccinate in the area in question.

Additionally, of course, the information acquired should serve to guide the vaccination programme as a whole in its subsequent activities.

With potent vaccine and proper technique, primary takes should be observed in at least 95 per cent. A level between 90 and 95 per cent. might be considered unacceptable and cause to appraise vaccinator techniques, storage conditions, etc., although generally not sufficient reason to reinstitute vaccination activities in the area. Any rate below 90 per cent. among primary vaccinees, whatever the coverage, should be cause to revaccinate widely in the area in question. If less than 90 per cent. primary takes have been obtained, it is quite possible that the potency of vaccine was less than optimal. Revaccination responses may be assumed to be even more grossly inadequate since a higher vaccine titre is required for successful revaccination than is required for primary vaccination. Vaccinator technique and vaccine potency should both be carefully checked. A field assessment of vaccine potency of a lot may be quickly performed employing approximately 100 primary

In areas of ~~poor~~ ^{poor} movement, revised surveys should be more often conducted.

vaccinees. If impeccable technique is used, no difficulty should be experienced in getting at least 95 per cent. vaccination responses. If it is less than this, the vaccine should be retained for titration in a laboratory.

So far as the minimum extent of coverage is concerned, it is tentatively suggested that a minimum 80 per cent. coverage of each age-group in each of the several segments of a city or town be accepted as satisfactory. Less than this would demand a re-examination of operational methods and extended vaccination in the area.

6. Vaccination and smallpox scar survey

It may be of interest to have information about the extent and effectiveness of vaccination activities in the past as well as some appreciation of the extent of smallpox (as measured by evident scars). Examination of vaccination and smallpox scars in the population as a whole and in young children in particular provides the most easily obtainable data with respect to vaccination and disease activity in an area in recent years. For example, if almost no children under three years of age have typical vaccination scars, and of those three to four years old, 50 to 60 per cent. have vaccination scars, it is reasonable to conclude that there was a vaccination programme in this population about three years ago but that the coverage and/or percentage of "take" was not very good. Similarly, if the rates of disease scars are, for example, 10 to 15 per cent. in persons aged eight and above, but none are observed in younger children, it may be inferred that comparatively little smallpox has been in the area for the past seven years.

A survey for vaccination scars is probably the only practicable method available for assessing a maintenance vaccination programme which employs, for example, one or two vaccinators assigned to a population of 10 000 to 20 000 persons. Total assessment or a sample survey assessment may be applied for this type of survey. Special emphasis again should be placed on surveys of more densely crowded areas, fringe population, etc.

7. Challenge vaccination

Challenge vaccinations have been proposed as a method for ascertaining the levels of immunity in a population¹⁶. This presumes, of course, that vaccination "take rates" can be equated to immunity level. Although the "challenge vaccination" approach would seem rather logical, difficulties are encountered in interpreting the findings. Reading of responses is very difficult and, even with trained observers, the frequently encountered minimal responses may be read as positive by one observer and negative by another. Differences of 20 per cent. may well be encountered based solely on interpretation of responses. In some instances, in which a fully potent vaccine has been employed with good technique, 80 to 90 per cent. of recent revaccinees have demonstrated "major reactions"^{17,18}. In such circumstances, such an approach as this is of little value in discerning individuals recently vaccinated from those vaccinated at some time in the past but in whom immunity may have waned.

In brief, the procedure simply cannot be recommended.

8. Serological surveys

The logistics of bleeding significant numbers of persons and the cost and complexity of laboratory testing precludes sampling a meaningful number of persons. Serological surveys may be useful under highly selective circumstances but, at this time, represent a research tool rather than a practical operational tool.

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SAMPLE VACCINATION TALLY SHEET

Age Group	Primary Vaccines	Age Group	Revaccines
0-4	<div style="display: flex; justify-content: space-between;"> <div> IIII IIII IIII III IIII IIII IIII IIII IIII IIII </div> <div style="text-align: right;"> 15 35 </div> </div>	0-4	
5-14		5-14	
15+		15+	

TEAM NUMBER _____
 PROVINCE _____
 MED. DISTRICT _____
 DATE _____
 VACCINATION AREA _____
 POPULATION ESTIMATE _____
 SMALLPOX VACCINE
 LOT NUMBER _____

PAGE SUMMARY

	Primary vaccines	Revaccines	TOTAL
0-4			
5-14			
15+			
TOTAL			

SIGNATURES: RECORDER TEAM LEADER

Note: 1. Boxes by age group are roughly proportionate to population distribution in most endemic areas
 2. If sex is to be recorded instead of vaccination status, males may be recorded on the left and females on the right

VI-17/18

ANNEX I

SAMPLE VACCINATION SUMMARY SHEET

TEAM NUMBER OR VACCINATOR _____

DATE STARTED _____

PROVINCE _____

DATE COMPLETED _____

MEDICAL DISTRICT _____

VIALS SMALLPOX VACCINE USED _____

AREA _____

	Vaccination Site Post, s District or hospital	Number vaccinated						Total
		Primary vaccinees			Revaccinees			
		0-4	5-14	15+	0-4	5-14	15+	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
	TOTAL							

RECORDER _____

TEAM LEADER _____

Country _____

NATIONAL QUARTERLY SUMMARY OF VACCINATIONS PERFORMED
(to be submitted to WHO)

Vaccinations performed during 3-month period _____ to _____

Province	Estimated Population	Total Vaccinations	Primary Vaccinations	Revaccinations

Comment: If any vaccinations performed with other than freeze-dried vaccine please indicate approximate quantities and areas where used.

Note: Quarterly summaries requested for periods

I	January-February-March
II	April-May-June
III	July-August-September
IV	October-November-December

Send two copies to WHO Regional Office

To be sent 15 days after close of reporting period whether or not information is complete.

TABLE OF RANDOM NUMBERS

Random number tables may be used for making random choices in the same manner as tossing a coin to decide between two alternatives or casting a single die to select randomly one of six possibilities. The advantage of the random number tables lies in the fact that adjustments can quickly be made to select one or more out of any number of possibilities. The short table included here consists of columns of two-digit numbers ranging from 00 through 99.

As an example, assume that one wished to choose at random a number from one through 17. Proceed in selecting a number and if the number found is in the range 1-17, "05" for example, take 5 as the chosen number. If the first number observed falls outside the range 1-17 continue down the column until a number falling within the range 1-17 is obtained.

Annex IV

TABLE OF RANDOM NUMBERS

42	30	23	87	49	19	38	18	41	96	06	26	87	97	00	63	30	37	40	25
24	29	42	59	75	56	23	86	92	65	58	36	01	17	65	53	51	03	80	59
38	84	27	64	95	05	05	49	73	86	94	44	54	27	28	82	96	76	04	52
79	14	98	28	26	89	57	06	50	58	74	66	16	15	62	19	70	25	52	48
18	73	65	06	62	47	68	83	61	98	92	20	63	29	85	35	70	67	19	09
62	53	12	65	30	27	33	71	39	57	88	57	52	92	64	78	71	18	61	99
96	21	03	76	26	41	57	49	10	08	61	38	64	51	04	06	03	52	79	94
81	72	57	66	45	92	71	89	31	53	45	41	17	52	24	07	25	83	16	21
57	48	47	27	21	83	57	08	06	13	27	43	52	10	12	53	44	39	63	32
75	36	68	03	56	16	87	37	77	72	34	56	65	99	45	62	25	54	24	09
41	68	73	93	85	69	12	79	09	02	53	95	80	75	00	94	19	68	56	06
87	17	74	47	91	92	03	62	94	52	91	31	97	29	14	19	21	45	99	30
70	36	84	17	41	36	36	35	40	22	19	68	69	18	56	74	94	56	86	76
10	85	11	47	70	60	17	80	52	62	31	45	81	04	37	69	14	25	93	23
81	55	99	81	67	91	81	95	55	23	96	88	06	35	96	73	60	06	40	35
75	92	09	26	92	50	99	26	36	09	81	42	04	50	47	76	13	15	30	32
60	71	28	71	78	45	47	75	98	26	96	46	45	61	58	67	25	50	90	09
41	01	70	57	56	04	02	66	65	46	33	67	73	09	42	33	05	71	92	02
56	41	77	07	17	78	10	85	27	55	51	21	74	66	42	14	49	25	23	13
58	27	06	67	31	90	65	58	13	53	32	21	85	76	77	22	45	13	81	77
19	24	74	72	91	24	37	30	82	05	41	37	09	87	93	79	14	30	45	82
66	27	05	35	26	55	49	80	89	18	58	30	21	91	10	46	76	56	81	71
96	16	52	86	84	54	22	70	37	09	81	66	32	18	49	04	52	45	87	55
36	18	19	64	98	51	76	31	12	30	86	30	95	31	93	66	80	28	90	86
59	73	20	25	60	60	32	29	67	17	36	54	33	90	07	27	41	95	24	78
07	78	22	51	91	91	73	20	00	60	73	07	38	33	49	49	96	57	11	05
31	20	45	95	40	06	76	37	95	23	14	28	72	36	80	56	35	05	76	51
49	60	74	61	89	34	05	59	09	40	89	04	12	74	57	58	38	09	40	55
75	87	42	46	17	55	88	89	60	55	96	99	70	37	37	64	13	23	97	96
72	15	39	97	53	65	96	60	00	15	78	54	95	25	7	83	88	13	33	46

