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AND ASSESSMENT IN SMALLPOX ERADICATION

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## ASSESSMENT OF THE VACCINATION COMPONENT OF THE PROGRAMME

from the revised

Handbook for Smallpox Eradication Programmes in Endemic Areas

### 1.0 Introduction

Assessment of progress in the vaccination programme is important and necessary. Nevertheless, one must continue to keep in mind that the one objective of smallpox eradication is to interrupt transmission of the disease. Thus, every programme must finally be appraised in terms of its success in reaching the goal of '0' cases of smallpox and its ability to maintain this status. If only 50% of a population is vaccinated but smallpox transmission is interrupted, the programme is considered to have achieved its primary goal. On the other hand, the performance of millions of vaccinations, even if greater in number than the total of the population, may not constitute a successful programme. Such programmes are successful only if smallpox transmission is interrupted.

Special programmes of vaccination are being conducted in all smallpox eradication projects. The objective of these programmes is to improve the immunity level of the population in order to decrease the extent of smallpox transmission. Fewer outbreaks occur and the disease spreads more slowly. Surveillance-containment teams are thus better able to investigate and contain cases and outbreaks which continue to occur.

Through continuing assessment of the vaccination programme, programme supervisors obtain information regarding the productivity of the vaccinators and vaccination teams, the quality of their work in obtaining satisfactory coverage and take rates, and the quality of the vaccine as used in the field. This information must continually be examined to determine weaknesses in the programme and to correct these weaknesses. The collection of assessment data is a meaningless exercise unless it is regularly examined and appropriate action is taken.

In assessing the progress of vaccination activities, several measurements have been found to be useful:

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- 1) The number of primary vaccinations and total vaccinations performed each month in each area, province/state and in the country as a whole.
- 2) The proportion of vaccinations which were successful.
- 3) The proportion of persons protected by vaccination in each area.

## 2.0 Tabulation of number of primary vaccinations and total vaccinations performed

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

- a) to determine the productivity (number of vaccinations performed daily or weekly) of vaccinators and teams;
- b) to provide mobile vaccination teams with estimates of the coverage obtained in a village or area prior to their departure.

In the past, only the total number of vaccinations has been recorded. More recently, however, the full importance of primary vaccination has been appreciated. Studies conducted during recent years have shown that, in endemic areas, 90% to 97% of all cases occur in persons who have no scar of primary vaccination. Vaccination of individuals who have no scar of primary vaccination is, thus, exceedingly important. Vaccination of one unvaccinated person may be as effective as revaccinating 100 or more persons who have been previously vaccinated. Most programmes, therefore, request a tabulation both of total vaccinations performed and of primary vaccinations performed.

In addition to a tabulation of vaccinations performed, other techniques of assessment (as described in subsequent sections) must also be used. A simple tabulation of vaccinations performed does not provide adequate information as to the actual proportion of the population vaccinated nor the success of vaccination. The problem in relying simply on a count of vaccinations performed may be illustrated by two programmes. In one, a great many vaccinations were performed; officials calculated that "140 per cent of the population had been vaccinated". However, special surveys revealed that only 70% of the people had actually been vaccinated but that school children and certain other accessible groups had been 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 Use of a 'tally sheet' for recording numbers of vaccinations

A tally sheet is one of the simplest devices for tabulating numbers of vaccinations performed. At the time of vaccination, a mark is made on a sheet to indicate that a person of a given age-group has been given primary vaccination or has been revaccinated (sample sheet - Annexe 1). To determine if a person has been successfully vaccinated previously, it is necessary to examine his arm to see if a smallpox vaccination scar is present. If no scar is present, he is considered to be a primary vaccinee whether or not he says he has been vaccinated before. Many persons

have been "vaccinated" in past years with unsatisfactory vaccine but have not had a vaccination take.

Usually, one tally sheet is used for each day for each vaccinator or vaccination team. The number of vaccinations performed each day may then be determined. Even under extremely difficult conditions, it has been found that the average vaccinator can readily perform at least 25 primary vaccinations and 75 revaccinations daily. In well-supervised programmes in Africa, vaccinators normally perform an average of 250 to 500 vaccinations daily.

Individual tally sheets are reviewed by a supervisor who prepares a summary for submission to programme officers at higher level (sample sheet - Annexe 2). Supervisors or central programme officers should regularly compare the number of vaccinations performed and the number of vials of vaccine consumed in order to permit better planning in respect to the flow of vaccine supplies and to determine whether there is excessive wastage.

Where possible, the number of vaccinations performed in each village, town, or population area is compared to the estimated population. Population estimates are usually obtained from census data, the malaria programme, etc. and while sometimes unreliable, they usually provide some reasonable estimate of population size. Using these estimates, vaccination teams engaged in systematic vaccination programmes may determine the approximate coverage before leaving an area. If the coverage appears low, they may remain in the area to search for unvaccinated groups of persons.

In countries where vaccinators are assigned areas in which they are to work throughout the year, a goal of 'X' number of primary vaccinations may be established. The performance of vaccinators may be measured in relation to their success in reaching this goal. The goal in terms of primary vaccinations may be established by multiplying the number in the population by 4% (the usual proportion of babies born each year) and adding some additional percentage (equivalent to perhaps 2% or 4% of the population) which would represent previously unvaccinated persons (the "unvaccinated backlog").

## 2.2 Tabulation of vaccinations on the basis of bifurcated needles used

A simplified technique for tabulating the number of vaccinations performed consists of counting the number of needles used during the day. This approach has been successfully used in Afghanistan. The vaccinator is provided with a container of sterile needles and an empty container. After each vaccination, the used needle is deposited in the container for used needles and the number is counted at the end of the day's work or after completing work in a village. This number is reported to the supervisor, who records the information on a special form. Using this technique, the vaccinator is not required to carry either pencils or paper and is able to work faster. An assessment team, one to two weeks later, determines the extent of coverage by age group as well as the proportion of primary vaccinees (see section 4.0).

In programmes where a continuing vaccination programme is in progress with vaccinators assigned permanently in an area, it is necessary for the vaccinators to tabulate the number of primary vaccinations performed. The Afghanistan technique described might be adapted to this situation by providing two containers for used needles - one for needles used for primary vaccination and one for needles used for revaccination.

### 2.3 Use of a household roster in house-to-house vaccination

In some programmes employing house-to-house vaccination, a "household roster" has been prepared which includes the names of all persons living in a house and their vaccination status. Individual rosters for a village or an area of a town have been kept at the local health post or administrative centre for use in follow-up vaccination. It was originally thought that by this means, more complete coverage would be obtained. However, this system has proved to be virtually unworkable. Aside from the fact that the recording of all names in this manner is highly time-consuming, it has proved impossible to keep such records up-to-date, complete and accurate. Few vaccinators have been sufficiently conscientious or diligent to provide complete and usable records. Because very large numbers of staff have been required, poorer quality personnel have had to be employed. Fraudulent reports have been common. Only under very unusual circumstances with highly disciplined populations, a large complement of reliable vaccinators and excellent supervision, should this system be considered.

A modification of this approach using a highly simplified household roster has been employed in some programmes with, at least, some success. A record form has been prepared in which on one line is listed the address of the household, the number of persons in each age group, (0-4, 5-14 and 15 years and older), and lastly, the numbers of persons in each of these age groups who were vaccinated during the time of the vaccinator's visit. An assessment team later uses these forms to determine take rates and to verify the accuracy of the information submitted. The forms are not used, however, as a permanent record and are destroyed after the visit of the assessment team. Even a simplified system such as this is not recommended for general use in the smallpox programme. Preparation of such records is very time-consuming and thus the programme requires employment of considerably larger numbers of reasonably well-educated persons. Recent experience indicates that equally satisfactory results are obtained with much simpler and far less expensive methods.

### 3.0 Assessment of vaccination take rates

A continuing assessment of vaccination take rates is necessary to assure that the vaccine as actually used in the field is potent and that a vaccinator's technique is satisfactory. In the smallpox eradication programme, assessment is based entirely on the response of primary vaccinees. There are several reasons for this. A "take" following primary vaccination is very obvious. A virtually untrained person can examine a group of primary vaccinees and determine which have "takes" and which do not. Evidence of a successful take will be present for as long as four weeks or more after vaccination. On the other hand, when one examines revaccinees during the recommended 6 to 8 day period after vaccination, some of the "major

reactions" will be barely detectable, although others may almost resemble a primary take. Different observers will disagree in respect to a significant proportion of those with minimal reactions. For example, in one study of a single group of children examined independently by different experienced WHO smallpox staff, the proportion read as having "major reactions" ranged from as low as 50% to as high as 80%.

Interpretation of the results reported from the field is also considerably easier in regard to primary vaccinees. In primary vaccinees, take rates are invariably higher than 95% when potent vaccine and satisfactory technique are employed. In a group of recent revaccinees, however, take rates may be, for example, as low as 70% while, in another group not recently vaccinated, 90% may show major reactions, despite the use of identical vaccine and technique in both groups. Assessment and interpretation of vaccine response in respect to primary vaccines is obviously the only satisfactory approach.

As most primary vaccinees are in the age group of 0 to 4 years, take rates are determined in this group only. If more than 95% of primary vaccinees have takes, the vaccine and vaccination technique are considered to be satisfactory. If the group assessed is small in number (less than 50) and the take rate is found to be between 90 and 95%, a larger group in the area (50 additional children) is examined to verify the findings. If the take rate is less than 95%, both the vaccine and the vaccination technique must be carefully checked. Primary take rates below 90% are definitely unsatisfactory. Both vaccination technique and vaccine quality should be investigated immediately.

In systematic vaccination programmes, independent assessment teams determine both vaccination take rates and completeness of coverage (see 4.0). In programmes where a continuing vaccination programme is in progress with vaccinators assigned permanently in an area, supervisors normally undertake this function (see 4.0).

#### 4.0 Methods for continuing assessment of vaccination coverage and take rates

The work of all vaccination teams and vaccinators must be continually evaluated to determine if coverage is complete and if primary take rates are higher than 95%. This assessment must be performed by an independent assessment team or supervisor to reduce the likelihood that the results will be falsified in any way. Experience has shown that when the work of vaccinators is evaluated in this manner and necessary corrective or disciplinary measures taken, the productivity of the vaccinators increases markedly and the quality and thoroughness of their work improves greatly.

To examine every person in every village where vaccinators have worked would require almost as many assessors as vaccinators. A programme with this goal would be far too expensive and, in practice, is not necessary. Instead, a sample of between 5% and 10% of the population is checked. Since the vaccinators are not informed which areas will be assessed, they must maintain a high level of performance at all times to assure that good results are found when a sample area is assessed.

In all areas, the largest proportion of unprotected persons is found among children and in most areas, more than 80% of cases occur in children. In countries where there are comparatively few unprotected adults and where it has been found that most cases occur among children, adults are customarily not examined for vaccination scars during assessment. This further simplifies the procedure as many adults work in the fields or are away from home during the day and cannot be examined except early in the morning or late in the day.

#### 4.1 Procedure for assessment in systematic programmes

In a programme in which vaccination teams are systematically vaccinating throughout the country, one assessment unit of two persons can assess the work of 20 to 30 vaccinators organized in vaccination teams. The number will vary depending on the terrain and dispersion of the teams. Assessors should be specially selected for educational background and dependability. Normally, they are of the calibre of team leaders. Assessment should take place between 7 and 14 days after the team has visited the area. At least 7 days must be allowed for vaccination takes to develop; if assessment is postponed beyond 14 or, at the most, 21 days, poor vaccination technique or poor general performance may continue for too long a time before being corrected.

A number of different methods are used to select the areas for assessment. Two methods are described: a highly simplified method and a more sophisticated approach, as presently used in Brazil.

##### 4.1.1 Simplified procedure for continuing assessment

As an example, the assessment team is given each week a list of all villages and areas vaccinated between 7 and 14 days before. The names of each village, municipal ward or other small area are written on separate pieces of paper and dropped in a box. The names of three sites are drawn at random from the box. One site is assessed each day. The supervisor selects two additional sites which he considers to be areas which might have been missed or not satisfactorily covered, e.g. slum areas, labour colonies, fringe areas of cities, villages which are relatively inaccessible by transport.

The team proceeds to the village or area selected for assessment and, after discussion of what is to be done with the village leader, selects a house from which to begin. An effort is made to examine all children who slept in the house during the preceding night. If children are playing elsewhere in the village, someone should be sent to bring them for examination. Results are marked on an assessment sheet (Annexe 3) following the directions printed on the back. (Note: if adults are to be examined, the sheet would have to be modified by adding 200 additional boxes). If the assessor is uncertain as to whether a particular scar is or is not a vaccination scar, he should assume it is not a scar and mark the box accordingly. When those in one house have been examined, he proceeds to the next house, and so on until an entry has been made in every box. Children whom the assessor meets or sees playing in the street should not be examined. If the assessor has visited all houses in a village and still has some boxes which have not been filled, he draws a heavy

line around the boxes which have been completed and then goes to the nearest village and continues working until all boxes are filled. Experience has shown that one form can be completed during one day's work even under difficult circumstances of travel.

When the assessor is finished, he adds up the number of symbols of each type and enters them in the appropriate box. The supervisor then checks the addition and calculations. If less than 80% of those under 4 years of age are unprotected or if the take rate is less than 95%, the programme supervisor investigates the situation and takes corrective action. In many programmes, teams are sent back to the area to revaccinate the village in question as well as other villages in the surrounding area. After they have done so, a repeat assessment is undertaken in several surrounding villages to assure that the work has been done properly.

#### 4.1.2 Methods for concurrent assessment - Brazil

An assessment survey method, developed and field tested in early 1968, has been routinely utilized by the Smallpox Eradication Programme in Brazil. This concurrent assessment method employs a simplified sampling scheme which can be understood by assessment personnel who have had 6 years of schooling or more. Each assessment team consists of two men who visit both urban and rural localities from 7 to 14 days following completion of vaccination. In a sample of households, vaccination coverage is determined for all residents; all primary vaccinees under five years of age are examined to determine the primary vaccination take rate.

The assessment teams are independent of the vaccination teams and are responsible only to the director of the programme in the geographic area in which they are working. One assessment team (two assessors) is responsible for the area covered by two team supervisors or a total of 8 vaccination teams (32 vaccinators).

The county is the administrative and geographical unit utilized both for vaccination and assessment purposes. The county seat is considered to be the only urban area in each county (there are some, but few, exceptions to this rule) and all other areas within the municipio are classified as rural areas for purposes of assessment. On the average, four counties are covered by 8 vaccination teams during one week's work. On Saturday, at the close of the work week, the two supervisors deliver to the assessment team a form which lists all the localities in the county where vaccination was completed during the previous week and the day on which each was vaccinated. There is one form for each county. The assessment team visits each county, spending on the average two days in each.

Urban areas - Fixed posts (using jet injectors) are utilized in the urban areas. It is known that persons from surrounding rural areas are attracted and a simple tabulation of vaccinees does not yield a reliable measure of vaccination coverage. This is, in part, due to the lack of reliable population estimates at this administrative level as well as the inclusion of non-residents in the

vaccination count. Thus, all urban areas are assessed.

The survey method has been designed to estimate the extent of vaccination coverage within a maximum of plus or minus 10% (with 95% certainty) for each of four age groups (0-4, 5-14, 15-44 and 45+ years of age). The necessary sample size has been calculated to be 200 children less than five years of age. Assuming an average household has five persons and in this population approximately 20% of persons are less than five years of age, there will be on the average one child under five years of age in every household. Thus, approximately 200 children less than 5 years of age should be found in 200 households.

For urban areas with less than 5 000 population, the following guideline is used:

<u>Estimated population</u>	<u>Estimated number of housing units</u>	<u>Sample to be selected</u>
Less than 1 000	1 - 200	All households
1 000 - 1 999	200 - 400	Every second house
2 000 - 2 999	400 - 600	Every third house
3 000 - 3 999	600 - 800	Every fourth house
4 000 - 4 999	800 - 1 000	Every fifth house

For urban areas with more than 5 000 but less than 50 000 population, a two-stage sample is used with the city block or "block area" serving as the primary sampling unit followed by a systematic sample of households within the block or "block area":

<u>Estimated population</u>	<u>Estimated number of housing units</u>	<u>Block</u>	<u>Households within block</u>
5 000 - 7 499	1 000 - 1 500	Every 3rd block	Every 2nd household
7 500 - 9 999	1 500 - 2 000	Every 4th block	Every 2nd household
10 000 -14 999	2 000 - 3 000	Every 5th block	Every 2nd household
15 000 -19 999	3 000 - 4 000	Every 6th block	Every 3rd household
20 000 -29 999	4 000 - 6 000	Every 7th block	Every 3rd household
30 000 -39 999	6 000 - 8 000	Every 10th block	Every 3rd household
40 000 -49 999	8 000 -10 000	Every 13th block	Every 3rd household

In urban areas up to 50 000 population, one assessor can interview up to 100 households in one day's work; thus, an assessment team will visit up to 200 households, the required sample size, in one day (see Assessment forms - Annexe 5 and 6).



Urban areas with more than 50 000 population present special problems. Assessment surveys for these areas are designed by the statistical staff of the Smallpox Programme.

Rural areas - Due to personnel and transport limitations, it is impossible to obtain assessment coverage of the entire rural area in each county. Therefore, one or more geographic areas are randomly selected in each county for independent assessment. In the area selected, every household is visited. Vaccination personnel have no prior knowledge of the area within the rural area that will be selected.

For example, in Annexe 4, the urban area and rural areas assessed in one county in the state of Santa Catarina are shown. On the first day of assessment, the urban area, which included the county seat, was assessed. In the rural area, there were 13 localities which represent well delineated farming areas in addition to the town or village nucleus. The area shown in the western portion of the municipio was randomly selected for assessment and was completed by early afternoon. When completed, there was ample time to assess another area which included the three localities immediately to the west of the federal highway.

The assessment form for urban areas of 5 000 to 50 000 population is shown in Annexe 5. The assessment form used for urban areas with less than 5 000 population (Annexe 6) is also used for rural areas. On the average, an assessor may visit from 50 to 75 households per day in the rural area depending on the density of population.

At the end of the week, a weekly summary of assessment results is prepared in duplicate. One copy is sent to the director of the local programme and the other copy forwarded to national headquarters (Annexe 7).

#### 4.2 Procedure for assessment in on-going programmes

In programmes where vaccinators are assigned an area where they are to administer vaccinations throughout the year, continuing assessment of their work is especially important. Experience has shown that in such programmes, supervision has frequently been poor, the productivity of the vaccinator has been low and the coverage has been unsatisfactory, particularly in pre-school children.

In such programmes, one supervisor can satisfactorily supervise and assess the work of 5 to 6 vaccinators. The supervisor should know the itinerary of all vaccinators for whom he is responsible and should know on what dates the vaccinator is supposed to have visited each village. Two routine assessments of the work of each vaccinator should be performed each month. There are several methods which may be used to select the sites for assessment. One method is to write on separate pieces of paper all villages, municipal wards, etc. which should have been visited during the period 7 to 21 days before. These are placed in a box and two are selected at random. Assessment of these two sites will require two days of work. The supervisor goes to the first village and proceeds in the same manner as described for the assessors under 4.1.1 above. For children under 5 years of age who do not

have an old vaccination scar, he must ask the mother whether or not the child had been vaccinated during the period 7 to 21 days before. Among this group, he is able to determine the vaccination take rate.

If the supervisor has 5 vaccinators and does two assessments of the work of each during the month, he will perform 10 assessments in this period. In addition, he should undertake at least four special assessments of sites where vaccination coverage is apt to be poor. Such sites would include labour camps, slum areas, migrant groups, etc. It has also been noted that villages adjacent to those where outbreaks have occurred are often found to be poorly immunized while the afflicted village is often well-vaccinated as a result of special vaccination after the outbreak has occurred.

The work of the supervisors in assessment should be regularly examined by a senior supervisor who should undertake to verify the results of at least one of the supervisors' assessments each month.

## 5.0 Periodic overall population assessment

A special periodic evaluation of the programme is often useful for future planning. Such an overall assessment is usually conducted every two or three years. A scar survey in a representative sample of the population is performed to estimate the number of unprotected persons in the country and in selected areas.

Such a survey can be conducted at relatively low cost and in a period of 4 to 6 weeks.

In the following, the principles are discussed regarding the preparation, implementation and execution of an overall population assessment of immunization status.

### 5.1 Sample selection

#### 5.1.1 Age groups

Examination is usually limited to the age group below 15 years because, in most countries, the overwhelming majority of smallpox cases occur in this age group and, in countries with regular vaccination programmes, most adults have vaccination scars.

The age group below 15 years is divided into three groups - infants (below 1 year), toddlers (1-4 years) and school-age children (5-14 years). Examination of those below 4 years provides information regarding recent vaccination activities as well as recent smallpox occurrence.

#### 5.1.2 Sampling

To determine an appropriate sample size and its distribution, the assistance of a statistician is useful, although not a necessity. In a reasonably homogeneous population, a sample of 20 000 children distributed over

at least 4 regions of the area can provide the required information. If personnel, time or transport is limited, however, a sample consisting of 4 000 to 5 000 children will provide a reasonably adequate indication of the proportion of unprotected persons in a population.

A sample of the population is selected through several separate steps. As a first step, a number of provinces (or comparable administrative units) are selected. This is often best done by selecting, for example, two which report a high incidence of smallpox, two reporting rates of intermediate level and one or two which report little or no smallpox.

In each province, at least two districts are randomly selected and in each district, five to ten villages or municipal wards. This selection of provinces, districts and villages is best done on the basis of available population data. An example will illustrate the procedure.

In a province with 7 districts, 2 districts must be selected. First the districts are listed together with the best available population data. These population figures are then added district by district:

<u>District</u>	<u>Population (in 000's)</u>	<u>Cumulative total</u>
A	328	328
B	456	784
C	264	1 048
D	719	1 767
E	516	2 283
F	712	2 995
G	530	3 525

With the help of a table of random numbers, two figures of four digits are selected, for example 0905 and 2923. The districts which include these numbers are selected, namely districts C and F. The absence of a random number table, an easy alternative is to examine bank notes which one may have and to take the last four digits of the serial numbers on the notes.

If population data are not available or are considered to be grossly unreliable, the problem can be solved by taking a map and drawing at equal distances 5 horizontal and 5 vertical lines. Number the lines and randomly select a horizontal and a vertical line. The district in which the two lines cross each other is selected. Similarly select a second district. An alternative approach is to list the districts alphabetically and to give each a number. Two of the districts are selected using a table of random numbers.

These last two methods for selecting districts are not so desirable; selection on the basis of population data is strongly preferred.

Selection of villages can be done in the same manner.

After selection of provinces, districts and villages or municipal wards, clusters of houses within these villages or wards are then selected for survey. Selection of the clusters of houses can be done in various ways. One way of doing this is to select a particular point in a village (for example, house of village chief, church, central square) and from there proceed in a randomly selected direction (for instance, with the help of a compass) or in a pre-determined direction (for instance, to proceed along the street taking alternately each left and right turn).

### 5.1.3 Examination

Having arrived at the means by which houses are to be selected, guide lines must be prepared on how to proceed with the actual examination.

The following definitions which have proved useful in several countries, may be modified according to the local situation. A house is defined as a residence with kitchen facilities, and residents as those who use these facilities and have slept in the house during the previous night. Schools, business establishments and factories are excluded from the survey. If information regarding the age of children is considered unreliable, the following criteria may be used:

- a) If upper incisor teeth are absent: less than one year old;
- b) If upper incisor teeth are present: more than one year old;
- c) If child cannot reach over the head within an inch of the upper edge of the opposite ear lobe: less than five years old;
- d) If the child can reach over the head and touch the upper edge of the opposite ear lobe: more than five years old.

An attempt should be made to examine all children residing in the selected houses. The assessor should, therefore, do the examinations by house to house visits. In conducting the assessment, it should be borne in mind that the largest proportion of children is usually found at home early in the morning and late in the evening around mealtime. Children outside the house but within calling distance should be collected.

Examination is limited to the face to check for the presence of pockmarks and to the arms for the presence of a vaccination scar. Pockmarks are considered to be present if there are at least five pocks on the face with a diameter of more than 2 millimetres. A vaccination scar is considered to be present if there are one or more depressed scars on the arm with a diameter of at least 5 mm and there is no keloid formation present in these scars. Inexperienced assessors sometimes have problems in differentiating BCG and smallpox scars. The former is often located much higher on the shoulder or on the forearm and is smooth and sometimes elevated above the skin surface.

For recording of the findings, the following symbols are used:

- P: Pockmarks are present (with or without vaccination scars);
- X: Vaccination scar(s) present;
- O: There are no pockmarks or vaccination scars;

If there is uncertainty whether a particular scar is a vaccination scar, it should be considered as not a vaccination scar.

#### 5.1.4 Staff requirements

With the exception of areas with very widely dispersed population, about 200 children can be examined by each assessor each day. With 10 assessors and 2 to 3 supervisors, about 10 days are required for the examination of 20 000 children. To this has to be added 2 days for initial training of the assessors, about 10 travel days and a few days for compilation and analysis of results.

#### 5.1.5 Interpretation of findings

##### A. Estimation of the number of unprotected persons

To estimate the total number of unprotected children in the population, it is necessary to make calculations separately for each age group, as shown below:

During a scar survey a sample of 50 000 children aged 0-14 were examined. The proportion of unprotected in each age group was found to be:

< 1 year	- 65%
1-4 years	- 25%
5-14 years	- 10%

The total population of the country is 20 000 000. The age-wise distribution of the population according to national data is as follows:

< 1 year	- 3.5%
1-4 years	- 12%
5-14 years	- 25%

The total number of children in each age group is, therefore:

< 1 year	-	700 000 (.035 x 20 000 000)
1-4 years	-	2 400 000 (.120 x 20 000 000)
5-14 years	-	5 000 000 (.250 x 20 000 000)

The calculated number of unprotected in the total population, applying the percentages obtained in the sample, is:

<u>Age</u>	<u>Population by age</u>	<u>% of unprotected in the sample</u>	<u>Estimate of pop- ulation unprotected</u>
< 1	700 000	65	455 000
1-4	2 400 000	25	600 000
5-14	5 000 000	10	500 000
Total	<u>8 100 000</u>		<u>1 555 000</u>

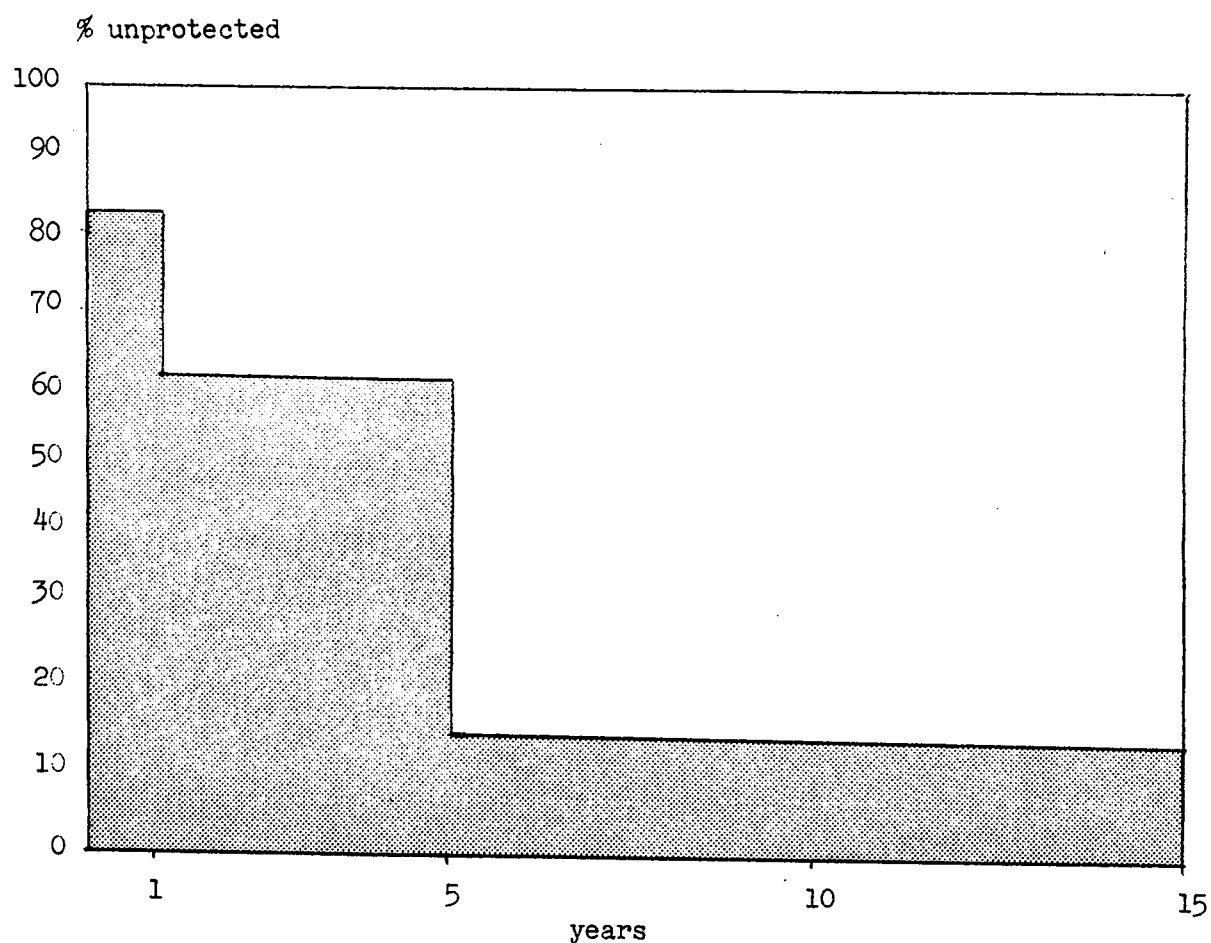
Conclusion:

Some 20% of the child population is unprotected. Two-thirds of this backlog is to be found in children below 5 years.

Another example is given below:

Summary of Scar Survey in Children under 15 years of age, and  
Estimates of Number of Unprotected Children (November 1969)

THAILAND



Estimated number of unprotected Children in Thailand, November 1969

	<u>Percent of children in each age group</u>	<u>No. of children in each age group</u>	<u>Percent of unprotected children in each age group</u>	<u>No. of unprotected children</u>
< 1 year	3.4	1 175 000	83	975 000
1 - 4 years	12.9	4 458 000	62	2 764 000
5 - 14 years	26.9	9 297 000	15	1 395 000
All	43.2	14 930 000	34	5 134 000

B. Estimation of smallpox reporting efficiency

If the sample is reasonably representative and is sufficiently large, and smallpox has recently been prevalent, there may be enough children in the age group 0 to 1 year or in the age group 0 to 5 years to permit an estimate to be made of the completeness of reporting of smallpox cases over the last 12 months or over the last 5 years as shown in the following example:

During a scar survey in a country with 20 000 000 population, 50 000 children, aged 0-14 years were examined. Among these children, 5 900 were below 1 year of age and 15 had visible pockmarks. In this country, approximately 20% of all smallpox cases occur among those less than 1 year of age and in this age group the case fatality rate is about 40%. It has been found that about 5% of these children recover without visible pockmarks. The number of cases of smallpox which have occurred in the past year may be estimated as follows:

1. The proportion of children with pockmarks aged 1 year and less in the sample is:

$$\frac{15}{5\ 900} \times 100 = 0.25\%$$

2. As the age group below 1 year represents 3.5% of the total population of this country, the number of children in this age group will be:

$$20\ 000\ 000 \times 0.035 = 700\ 000$$

3. The total of children below 1 year with pockmarks is therefore estimated to be:

$$\frac{700\ 000 \times 0.25}{100} = 1\ 750$$

4. 1 750 children with visible pockmarks represent 55% of all cases of smallpox in this age group (40% died; 5% recovered without pockmarks). Therefore the total number of children aged 1 year and less, who contracted smallpox in the preceding year is estimated to be:

$$1\ 750 \times \frac{100}{55} = 3\ 182$$

5. As approximately 20% of all smallpox cases occur in children below 1 year, the total number of smallpox cases in the country during the preceding 12 months may be estimated by multiplying 3 182 by 5.

$$3\ 182 \times 5 = 15\ 910$$



6. During the last 12 months, 3 720 cases of smallpox had been reported to the directorate of health services. The reporting efficiency is therefore estimated to be:

$$\frac{3\ 720 \times 100}{15\ 910} = 23.4\%$$

7. Conclusion: During the preceding 12 months, about 25% of all cases of smallpox have been reported.

In a similar way an estimation can be made for the number of cases occurring during the last five years. However, the correction factors in respect to the age distribution of cases and the case fatality rate would have to be changed appropriately.

In this way a very conservative estimate is made of reporting efficiency. In fact, to be technically correct the number of infants calculated to have contracted smallpox should actually be doubled. This is apparent when one realizes that the average age of children examined is approximately 6 months. Thus the average period this population group could have been exposed to smallpox is only half a year. Even when this further correction is not made, results of many surveys to date show that reporting efficiency at the beginning of a programme or where a programme is progressing poorly, is usually only 5% to 10%. The calculations above may demonstrate rather clearly that reporting is very incomplete and whether 5% or 10% or even 20% is relatively immaterial as corrective measures are required, in any case.

ANNEX 1

SAMPLE VACCINATION TALLY SHEET

Age Group	Primary Vaccines	Age Group	Revaccines																							
0-4	++++    ++++    ++++ 15 ++++    ++++    ++++    ++++ 35 +++    ++++    ++++	0-4																								
5-14		5-14																								
15+		15+																								
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: left;">PAGE SUMMARY</th> </tr> <tr> <th style="width: 30%;"></th> <th style="width: 30%;">Primary vaccines</th> <th style="width: 30%;">Revaccines</th> <th style="width: 10%;">TOTAL</th> </tr> </thead> <tbody> <tr> <td>0 - 4</td> <td></td> <td></td> <td></td> </tr> <tr> <td>5 -14</td> <td></td> <td></td> <td></td> </tr> <tr> <td>15+</td> <td></td> <td></td> <td></td> </tr> <tr> <td>TOTAL</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>				PAGE SUMMARY				Primary vaccines	Revaccines	TOTAL	0 - 4				5 -14				15+				TOTAL			
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0 - 4																										
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TEAM LEADER/VACCINATOR \_\_\_\_\_  
 PROVINCE \_\_\_\_\_  
 MED. DISTRICT \_\_\_\_\_  
 VILLAGE \_\_\_\_\_  
 DATE \_\_\_\_\_  
 SMALLPOX VACCINE \_\_\_\_\_  
 LOT NUMBER \_\_\_\_\_

## SAMPLE VACCINATION SUMMARY SHEET

TEAM NUMBER OR VACCINATOR \_\_\_\_\_ DATE STARTED \_\_\_\_\_  
 PROVINCE \_\_\_\_\_ DATE COMPLETED \_\_\_\_\_  
 MEDICAL DISTRICT \_\_\_\_\_ VIALS SMALLPOX VACCINE USED \_\_\_\_\_  
 AREA \_\_\_\_\_

	Vaccination area or site	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 \_\_\_\_\_

TEAM SUPERVISOR \_\_\_\_\_



Assessment should be conducted on a house-to-house basis until all squares are filled. Note one symbol in each square.

Each individual is checked first for pockmarks on the face indicating previous smallpox infection. If present, a "P" is marked. If there are no pockmarks, he should be checked for presence of a vaccination scar or recent vaccination take. If present, an "X" is marked. For children under four years, a primary take should be noted as ~~X~~. If there is no scar or vaccination take, an "O" is marked. For children under four years, an adult should be asked if the child was vaccinated during the previous two to three weeks. If the answer is "yes", a "e" should be noted. If the answer is "no", the single "O" is sufficient.

If the take rate is over 95%, the result is excellent; if 90%, it is satisfactory; if less than 90%, it is unsatisfactory.

In general, if the percentage unprotected in each age group is less than 10%, the result is considered to be excellent; if it is 15%, it is satisfactory; if more than 15%, it is unsatisfactory. In densely crowded areas, a higher coverage may be required.



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