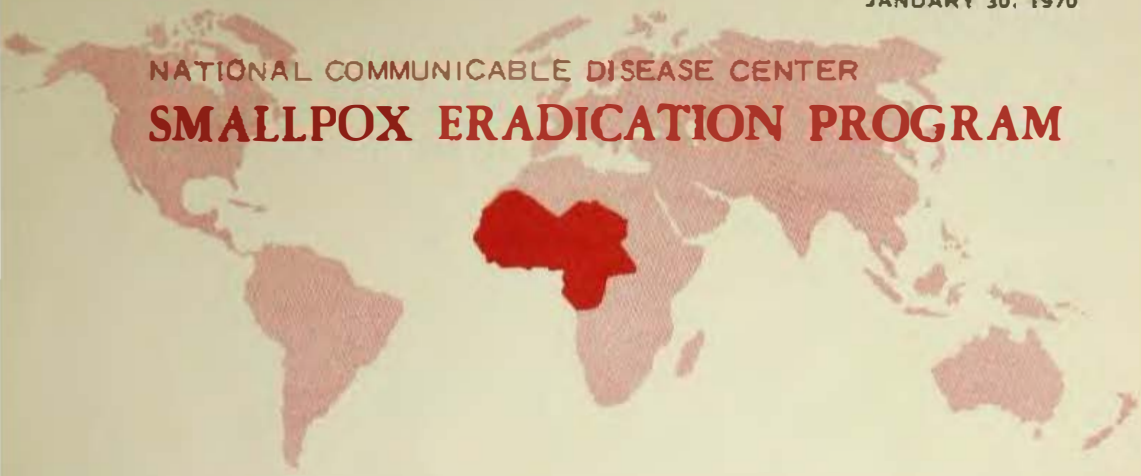
VOLUME IV, NUMBER 2
JANUARY 30, 1970

NATIONAL COMMUNICABLE DISEASE CENTER

SMALLPOX ERADICATION PROGRAM



THE SEP REPORT

SEMINAR ON SMALLPOX ERADICATION AND MEASLES CONTROL IN WESTERN AND CENTRAL AFRICA

Proceedings of a meeting held in Lagos, Nigeria, May 13-20, 1969 — Part II

Jointly sponsored by the: World Health Organization, the U.S. Agency for International Development, and the National Communicable Disease Center

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

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MEASLES

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EPIDEMIOLOGICAL CHARACTERISTICS OF MEASLES IN WEST AND CENTRAL AFRICA

J. D. Millar[1]

Seasonal Distribution

In this area measles is a disease of dry season epidemics (figure 1). The rains stop in September; after two to three months, measles epidemics appear and increase in frequency until May and June when the rains begin again. This pattern probably depends on the mobility of people. Markets, festivals, visits to relatives, etc., are dry season diversions; planting and cultivating during the rains keep people in their own villages.

Age Distribution

In all but the most remote areas, measles is a disease of the first two years of life (figure 2). In urban Africa, 90% of cases occur in children less than two years old. However, the data from the Western State in Nigeria indicate a somewhat later age of attack in less densely populated areas. Only in the remote areas where measles is probably an infrequent visitor, does the age pattern approach that or the USA. For example in the Kouapouli (Central African Republic) epidemic of 1967, the age distribution of cases and age specific attack rates suggest an interval of five to seven years since the previous epidemic (table 1).

The influence of population density on the age distribution of measles in Cameroon is shown in table 2. The rate of transmission appears to increase as the population density increases.

Various reasons are given for the high incidence of measles in very young infants in Africa. Morley suggests that the universal practice of carrying of infants on the mother's back expands the opportunity for contact. The extended family system and the intimacy of village life also augment the chances of infection. The occurrence of measles so early in life presents difficult problems to those who would control the disease through immunization.

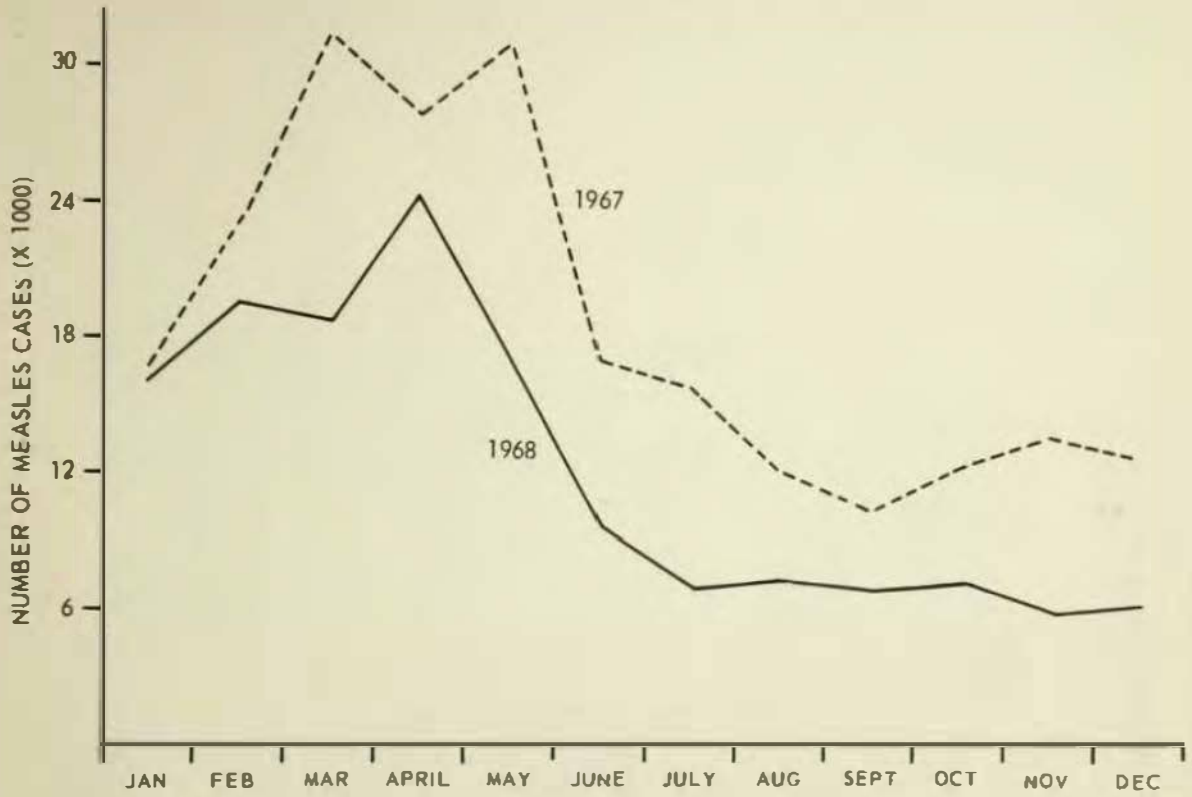
Death/Case Ratio

While of relatively less importance to the epidemiology of measles control, the death/case ratio is critically important in understanding the emotional and political impact of measles control programmes. As shown in table 3, measles is most lethal in the infant, but extorts a high death toll even in the older preschool child. Grigsby cites a case-fatality ratio of 14% for hospitalized cases in Ibadan. Rosenbloom reported a death/case ratio in Cameroon in 1965 of 10.5%, sufficient for measles to rank second only to malaria as a cause of death in children. There is no evidence that the etiologic agent is different from that in the USA nor that variations in host immunity play a significant role. The high death/case ratio in Africa appears to relate to the young age distribution of cases and the presence of malnutrition.

In summary, measles in West and Central Africa generally occurs as an epidemic disease of the dry season. Most children in urban areas have had the disease by two years of age, and a somewhat later age distribution is observed in rural areas. Measles transmission appears to increase as population density increases. Measles is a lethal disease in this area, being associated with mortality rates of 10% to 15% in hospitalized cases. This high mortality is believed to be the result of malnutrition, which is often most severe in the very age range in which measles most frequently strikes.

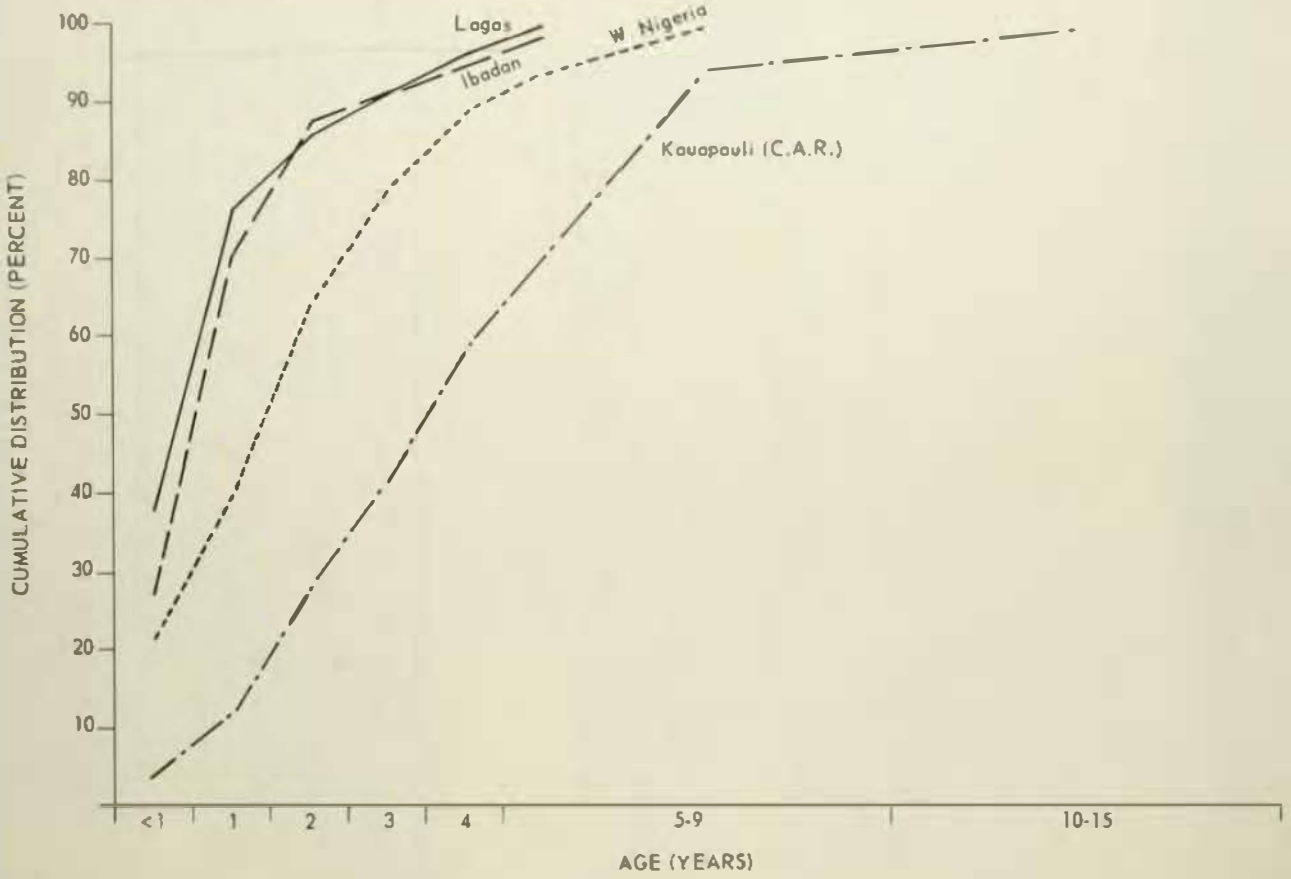
[1]Chief, Smallpox Eradication Programme, NCDC, Atlanta, Georgia, USA

FIGURE 1. SEASONAL DISTRIBUTION OF REPORTED MEASLES, WEST AND CENTRAL AFRICA*



*The SEP Report, Vol. III, No. 1, February 1969.

FIGURE 2
PERCENT DISTRIBUTION OF MEASLES CASES BY AGE
FOR FOUR AREAS[1,2,3]



1. Grigsby, M., Personal Communication (Western Nigeria)
2. E. A. Smith and S. O. Foster: To be published (Nigeria)
3. Durand, B. and N. H. Ewen, (Personal communication (Central African Republic)

Table 1

Measles Epidemic, Kouapouli, Central African Republic* (October 1967)
Percent Distribution of Cases by Age and Age Specific Attack Rates

Age (Yrs.)	Total Residents	Attack Rate (%)	Cases	Percent Distribution of Cases
<1	34	32.4	11	3.4
1	32	87.5	28	8.8
2	57	89.5	51	16.0
3	53	84.9	45	14.2
4	62	85.5	53	16.7
5-9	179	62.6	112	35.2
10-15	93	19.4	18	5.7
Total	510	62.4	318**	100.0

* An Area of subprefecture of Nola (pop. density 1.1 persons/Km.^{2})
** Excludes one case in 25 year old person.

Table 2

Measles, Cameroon (1965)
Cumulative Percent Distribution of Reported Cases by Age and Population Density of Reporting Area.

Area Density (per Km.^{2})	Cumulative Percent Distribution by Age				Case Total
	<1	1-4	5-9	10+	
<10	15.5	62.2	89.8	100.0	19014
10-40	20.7	63.2	90.2	100.0	19337
40-80	22.7	73.4	90.9	100.0	9435
80+	26.8	84.6	94.9	100.0	16825

Table 3

Measles Epidemic
Kouapouli, Central African Republic* (October 1967)
Death/Case Ratios by Age**

Age (Yrs.)	Cases	Deaths	Death/Case Ratio (%)
<1	11	3	27.3
1-2	79	11	13.9
3-5	134	7	5.2
6+	94	0	-
Total	318**	21	6.6

* An area of subprefecture of Nola (pop. density 1.1 persons/Km.^{2})

** Excludes one case in 25 year old person

MEASLES IN DOUALA

B. Peters[1], A. Delas[2]

INTRODUCTION

Douala, the largest city in Cameroon, is located on the coast and serves as the principal port for the country. It is primarily a commercial-industrial city which attracts people for business purposes for visits to relatives, and often for medical attention, from a radius of at least 100 kilometres. Measles is thus constantly being re-introduced into the city from distant towns and villages as children come to Douala to be treated or arrive in the city while incubating the virus.

The population of the city is estimated to be between 250,000 and 300,000. The population in the six month to six year age group is thought to be about 62,500 (25% of the population), and there are estimated to be 14,000 births annually.

History of measles prior to the campaign

As in other areas of West Africa, measles has, in the past, been one of the leading causes of childhood morbidity and mortality in the city. In 1965 and 1966, measles was responsible for 21% of all hospital admissions for transmissible disease. It ranked second only to malaria as a cause of death in children.

The pattern of measles in Douala prior to the introduction of the measles control programme can be seen in figure 1, which shows the number of cases hospitalized monthly at the Hopital Laquintinie from May 1959 to April 1968. The peak of the curve is usually reached during the dry season, between January and April, with a decline until the end of the year. Every two to three years the epidemic peaks are higher than in the intervening years. Over a seven year period prior to the vaccination campaign in Douala, the average number of cases admitted to this hospital was 322. This probably represents a little more than 2% of all cases occurring in the city.

Vaccination Campaign

In November 1966 the first measles vaccination campaign was conducted in Douala by the Service des Grandes Endemies and the PMI (Maternal-Child Health Centre). This is an out-patient centre opened in May 1965 which treats children from birth through the age of six years and sees about 25,000 children monthly. Following the mass campaign, the maintenance phase was turned over to the PMI which conducts monthly vaccination sessions at the Centre.

Table 2 shows the number of vaccinations given in Douala, by month, since the beginning of the programme. During the initial eleven day mass campaign, 47,816 measles immunizations were given. In this campaign, about 80% of the six month to six year age group of the target population was vaccinated.

During the following year, 1967, 10,315 maintenance vaccinations were given; in 1968, 20,581 children were vaccinated. It is estimated that 50% of these maintenance vaccinations were not effective for measles control since they were given to children who had already been vaccinated to those who had already experienced the disease, or to children who were visiting Douala from distant towns.

[1]Medical Officer Adviser NCDC/USAID, Yaounde, Cameroon

[2]Directeur des Grandes Endemies et de la Medecine, Cameroon

Measles-since the mass campaign

Measles cases are seen and reported from two centres in Douala, the PMI and the Hospital Laouintinie. Figures 1 and 2 show the curves for measles cases recorded at these two centres. From figure 1 one would have expected 1967 to be a particularly severe year for measles in Douala since it followed a year of relatively low incidence. However, during this year, which immediately followed the mass campaign, only seven cases of measles were admitted to the hospital, 2% of the average number of cases for the preceding seven years. The number of measles deaths fell from an average of 32 per year to nil. At the PMI, the number of cases which were seen also dropped to 2% of the preceding year. Thus, the mass campaign had an immediate and spectacular effect on measles morbidity and mortality in the city.

In 1968 there was a resurgence of measles. The epidemic curve was similar to that seen in the years before the campaign, with the peak occurring in the early months of the year. The cases numbered roughly 40% of the average number in years preceding the campaign.

During the first three months of 1969, cases were more numerous than in 1967, but they were still only about 15% of those seen in the years prior to the vaccination campaign.

The resurgence of measles in Douala in 1968, after a year of excellent control in 1967, can be explained both by the cases which came into the city from outlying, occasionally unvaccinated areas, (about one-third of the total), and by the steadily increasing number of susceptibles in the city.

The measles susceptibles

In figure 2 we have presented estimates of the monthly increase in the proportion of measles susceptibles in Douala. Of the estimated 62,500 six month to six year old children in Douala, 47,816 were vaccinated in the mass campaign of November 1966, leaving approximately 14,000 unvaccioated. Of these 14,000, at least half were considered to be immune due to natural disease. One year later 14,000 new susceptibles had been added by birth to this pool. The Director of the PMI estimated that only 5,000 of the 10,000 vaccinations administered in 1967 were given to susceptible children resident in Douala. The remainder were given to children who were already immune or who were only visiting Douala. This means that of the 14,000 new susceptibles 9,000 remained so at the end of the year. These 9,000 were in addition to the 7,000 susceptibles remaining after the mass campaign. At the end of 1967 then there were an estimated 16,000 measles susceptible children in Douala comprising about 25% of the six month to six year age group. This susceptible pool was large enough to permit the resurgence of measles. It is noted that at the end of 1966 when only 11% of this age group was susceptible, there was good measles control for one year. It would appear that to maintain good measles control in this urban setting, one would probably have to maintain the susceptible pool somewhere below 2%.

Two facts should be noted concerning the cases which have occurred since the beginning of 1968.

1. The age of measles cases has decreased.

Workers at the PMI noted that the average age of those with measles was decreasing (table 2). Prior to the campaign, 28% of the cases seen were less than one year old and 16% were more than four years old. In the 1968 epidemic, the percentage of cases less than one year old had increased to 33.5% while those more than four years old had decreased to 8.5%. Finally, in the first three months of 1969, those less than one year old represented 44.5% of the cases and only 1.7% of the cases were more than four years of age. For Cameroon as a whole in 1968, 25.8% of cases occurred in the 0 to 1 year age group, and 16.7% in the over 4 year age group.

2. Measles has occurred in previously vaccinated children.

Since the beginning of 1968, we have seen a large number of cases occurring in children who are said to have been previously vaccinated. Of 1,427 cases seen at the PMI from January through April in 1968, 34% initially claimed to have been vaccinated. Careful questioning reduced this figure to 18% by eliminating those who, in reality, had received BCG or smallpox vaccine but not measles vaccine as well as those children who were vaccinated during the incubation period of the disease. Of the remaining cases, some may have occurred in children vaccinated with poor technique or with vaccine rendered impotent by breakdowns in refrigeration. Some children may have been vaccinated at a time when maternal antibody was still sufficiently high to prevent vaccine infection. It may also be that some of these reported cases merely represent mild reactions to the measles vaccine.

Conclusion

Although the mass campaign was an overwhelming success and proved the efficacy of mass measles vaccination, the maintenance campaign has been less successful in preventing recurrent measles outbreaks. There continue to be approximately 15,000 susceptible children in the population who, along with the unvaccinated children visiting the city, maintain the disease at a low level and allow for periodic measles outbreaks.

TABLE 1

Number of Measles Vaccinations in Douala November 1966 to March 1969

Month	1966	1967	1968	1969
Jan.		240	1422	6614
Feb.		190	2678	2334
Mar.		267	4110	368
Apr.		530	3180	
May		854	1688	
June		1451	1892	
July		1839	1867	
Aug.		2251	785	
Sept.		889	525	
Oct.		701	980	
Nov.	47816 (mass campaign)	725	921	
Dec.	389	378	533	
Yearly totals =	48205	10315	20581	9316 (through March)

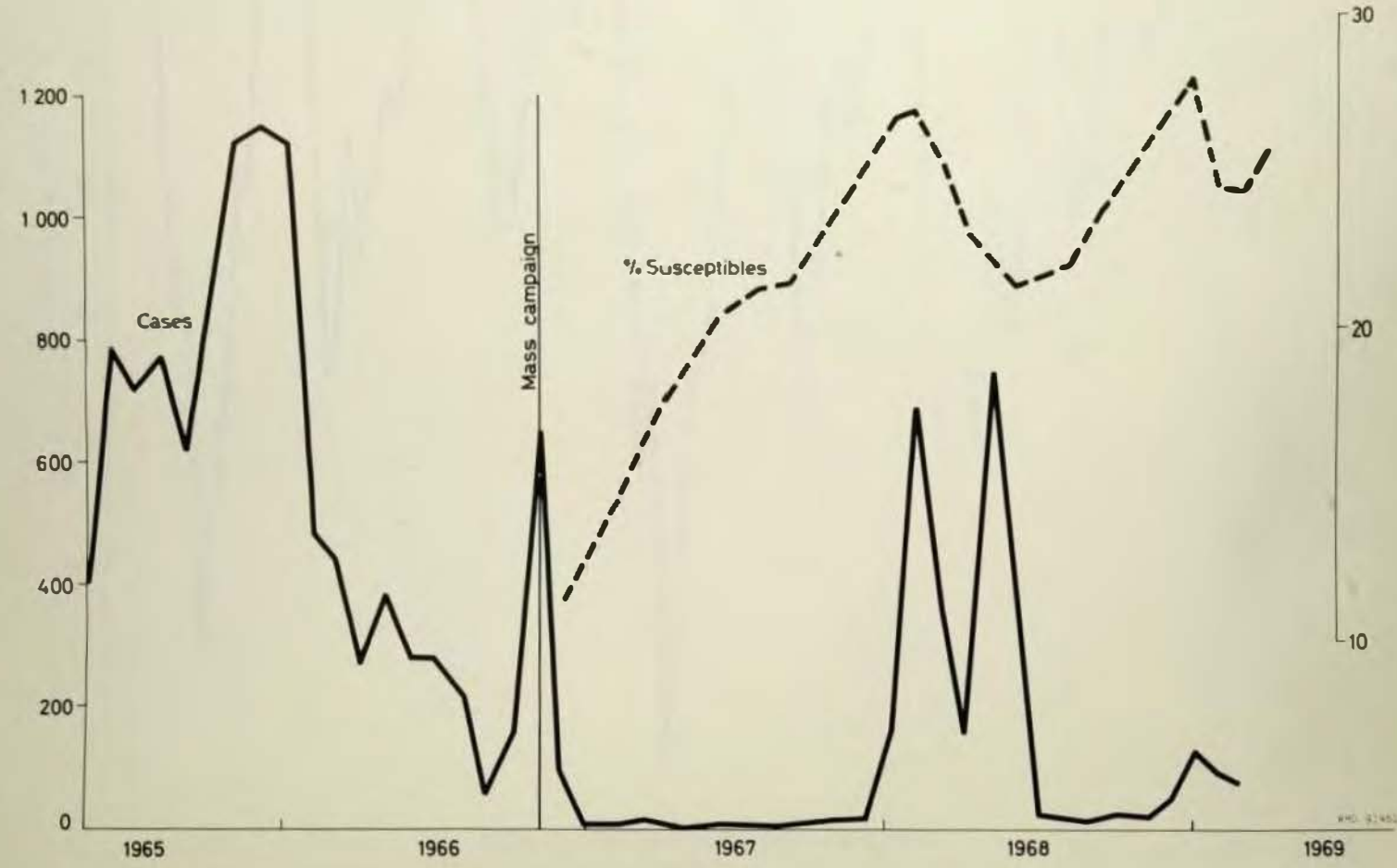
TABLE 2

Age Distribution of Measles Cases seen at PMI, Douala
Before and After Mass Vaccination Campaign

Age	Nov. 65 - Nov. 66 (6,000 cases)	Jan. 68 - Mar. 68 (1223 cases)	Jan. 69-Mar. 69 (290 cases)
<1 year	28%	33.5%	44.5%
1 - 4 years	55%	58%	53.8%
>4 years	16%	8.5%	1.7%

FIGURE 1
HOSPITALIZED MEASLES CASES IN DOUALA

FIGURE 2
MEASLES CASES REPORTED BY PMI AND ESTIMATED SUSCEPTIBLES – DOUALA



BOUAR MEASLES EPIDEMIC

CENTRAL AFRICAN REPUBLIC

N. Ewen[1]

For approximately three months, from October 15 to January 15, a measles epidemic ravaged the prefecture of Nana-Mambere in northwestern Central African Republic. Bouar, a city of about 20,000, the administrative centre for the prefecture, recorded the greatest number of cases, but many cases were also reported to have occurred in most of the smaller villages scattered throughout the remote bush. Though attack rates are unknown, they are believed generally to be high. The epidemic reached its peak in December. At that time a measles vaccination programme was belatedly begun in Bouar. The campaign was continued in January and February in those bush villages which had bad few or no measles cases. An investigation of the epidemic was undertaken from February 17 to 22 by which time no measles cases were seen in Bouar.

Bouar an economic and military centre, is a main stop on the route between Bangui and Yaounde, and is the second largest city in the country. The population density of the entire sub-prefecture is about 6.5 persons per square kilometre, making it one of the most densely populated prefectures in the country.

In each of the 31 months preceding the epidemic only a small number of cases were reported in Bouar (table 1). The date of the last previous measles epidemic in the town is unknown. Measles vaccinations had never been given in this area.

Between 100 and 150 deaths due to measles were said to have occurred in Bouar during the three month period of the epidemic. Since few of these were documented, a visit was made to the Etat Civil, an office charged with recording births, deaths, and other vital statistics, in the hope that some information could be obtained from their files. The visit failed to provide the necessary information.

A second possible source of information was the community itself. In two previous epidemic investigations the interview survey technique had been quite productive. This approach was tried in Herman, a quartier in Bouar, and in Maigaro, a bush village about 15 miles from Bouar. Ten man-hours of interviewing produced information regarding 450 children aged 0 to 10 years. One hundred and fifty of these children were reported to have contracted measles during the epidemic; the remaining 300 supposedly had never been infected. However, the survey results were felt to be unreliable. Birth certificates were presented for only about one-third of the children; many contradictory answers were given by family members; numbers of deaths reported by health staff and village leaders could not be confirmed through interview. Two possible sources of information remained, the Bouar General Hospital and the Herman dispensary hospital. The Bouar General Hospital had few data. Inpatient cases are usually limited to persons referred by one of the town's dispensaries. There is no out-patient service. These two factors combined to limit considerably the number of patients on whom information could be gathered. Only 25 measles cases were admitted from December 1, 1968 to February 22, 1969, of whom 10 died. This high mortality rate is not surprising since, in general, only seriously ill patients are admitted to the hospital.

A better source of information was the Herman Dispensary Hospital. This facility has an active outpatient service, an MCH service and about 15 beds for maternity cases and minor illnesses requiring hospitalization. From September 29, 1968, to February 22, 1969, a period of 21 weeks, the outpatient service saw 419 measles cases, and the hospital section admitted 137 measles patients. (The figures are not additive since an unknown number of persons seen by the outpatient service were later admitted to the hospital).

[1]Operations Officer, Advisor, NCDC/USAID, Bangui

Of 419 outpatient cases, about 18% were 5 years old or older (table 2), in the Kouapouli epidemic of 1967, 40% of the cases were in this age range. Six patients, about 1% of the total, were 15 years of age or older. Of the 231 cases less than a year old, the number less than six months old could not be determined.

Of the 137 children hospitalized with measles, 16% were five years old or older (Table 3). Nineteen deaths were recorded among the patients. The actual number may be higher because a few parents removed critically ill children from the hospital. Furthermore, a large number of bronchopneumonia deaths were recorded in the hospital during the epidemic, and a hospital nurse noted that several of the deceased had first had measles. Thirteen of the 19 known deaths occurred in children less than 3 years old.

There is a noticeable difference in the age distribution of hospitalized and outpatient cases in the 0-12 months age group. The number of children less than a year old constitute 55% of the outpatient cases but only 20% of the hospitalized cases. There are two possible explanations. Children less than a year old are not always hospitalized when medical care is needed because nursing mothers do not like to or cannot afford to be confined to a hospital with their children. This factor might limit the number of sick children who are actually hospitalized. A more likely explanation is the fact that all children less than a year old are seen as outpatients at the MCH center. This naturally tends to inflate the number of cases observed in this age group because these children appear weekly, well or ill, as regular participants in the MCH programme. Many of the cases occurred among children who came to the dispensary for their usual MCH visit and were coincidentally diagnosed as having measles.

TABLE 1

Reported Measles Cases, Bouar — March, 1966 - February, 1969

		Herman Dispensary	Haussa Dispensary	Total
1966	March	0	1	1
	April	0	0	0
	May	5	9	14
	June	6	4	10
	July	4	3	7
	August	7	6	13
	September	N.A.	N.A.	N.A.
	October	5	5	10
	November	3	9	12
	December	0	9	9
1967	January	7	2	9
	February	11	7	18
	March	4	6	10
	April	4	2	6
	May	15	2	17
	June	10	8	16
	July	4	6	10
	August	4	8	12
	September	1	1	2
	October	0	1	1
	November	2	3	5
	December	1	7	8
1968	January	0	0	0
	February	1	1	2
	March	3	0	3
	April	0	1	1
	May	1	1	2
	June	1	1	2
	July	0	1	1
	August	1	0	1
	September	1	1	2
	October	20	5	25
	November	194	28	222
	December	170	65	235
1969	January	55	16	71
	February	1	6	7

TABLE 2

Number of Outpatient Measles Cases by Age at
Herman Dispensary, September 29, 1968 to February 22, 1969

Age	Number	Percent of Total
Under 1	231	55
1-4	113	27
5-14	69	16
15+	6	1
Total	419	100

TABLE 3

Number of Hospitalized Measles Cases by Age Group
in Herman Dispensary
September 29, 1968 to February 22, 1969

Age	Number of Cases	percentage of Total	Deaths
0-5 months	1	.7	0
6-11 "	27	20.0	4
1 years	33	24.4	3
2 "	24	17.8	6
3 "	19	14.1	1
4 "	10	7.4	0
5 "	8	5.9	2
6 "	6	4.4	0
7 "	2	1.5	0
8 "	2	1.5	0
9 "	0	-	0
10 "	1	.7	1
11 "	2	1.5	1
TOTAL	135+	100	18++

MEASLES IN LAGOS

E. Ademola Smith[1]

S. O. Daniels[2]

S. O. Foster[3]

Measles in Lagos, as elsewhere in West Africa, is a disease of infants and young children. During the last two years, the Federal Ministry of Health in cooperation with Lagos State and Lagos City Council has undertaken special studies at the Lagos Defectious Disease Hospital (IDH). This hospital is located in Yaba on the border between Lagos City and the adjoining metropolitan areas (Lagos Urban). Prior to the initiation of the Measles Control Programme, approximately 4,000 cases of measles were admitted to the Lagos IDH annually. This is estimated to represent approximately 10% of the cases of measles occurring in the metropolitan area. An analysis by age of 10,078 consecutive measles admissions to the Lagos IDH is presented in Figure 1.

Table I presents the age and cumulative age distribution of these 10,078 measles cases.

Table 1

Distribution of Measles Cases by age groups in Lagos IDH 1965-1967

Age	Distribution (%)	Cumulative %
0 - 5 months	3.2	3.2
6 - 11 months	32.9	36.0
1 - 1.4 years	24.3	60.3
1.5 - 1.9 years	13.4	73.8
2.0 - 2.4 years	8.2	81.9
2.5 - 2.9 years	3.5	85.4
3.0 - 3.4 years	3.7	89.1
3.5 - 3.9 years	1.1	90.2
4 years+	9.8	100.0

In Lagos, 36% of cases occur before the first birthday and 60% by 18 months of age. It is theorized that the traditional practice of carrying young babies on the back as mothers attend markets, social, and other gatherings, is responsible for the early age of measles transmission in urban Africa. This heavy concentration of cases in the very young is much less common in isolated rural areas. In these rural areas of Nigeria measles has a definite seasonal (dry) and biennial distribution. However, as shown in Figure 2 measles in Lagos is endemic at all times of the year and reported cases do not reveal a definite seasonal pattern.

[1]Medical Director, Nigerian SPE/MC Programme, Lagos, Nigeria
[2]Medical Director, Lagos City Council SPE/MC, Lagos, Nigeria
[3]Medical Officer Adviser, NCDC/USAID, Lagos, Nigeria

MASS-VACCINATION CAMPAIGN

As part of the West African Smallpox Eradication Measles Control Programme, a smallpox-measles vaccination campaign was conducted in the Lagos area from July until December 1967 as a cooperative programme of the Federal Ministry of Health, the Lagos City Council, and the Ikeja District Council.

The campaign was conducted on a Ward by Ward basis, using fixed vaccination sites and mobile teams. Advance publicity and health education were provided by the Health Authority, Local Government, press and radio. Sound trucks, including those loaned by commercial firms, were used around vaccination site announcing the presence of the vaccination teams in the area.

During this period, 115,429 children from 6 months through 3 years of age were vaccinated by jet injector. Post campaign assessment was carried out independently using a random sampling technique. The assessment showed that in Lagos City 94.5% and in Lagos Urban (Mushin Shomola) 81.1% of the children in this age group had been vaccinated.

EFFECT OF MASS CAMPAIGN ON MEASLES INCIDENCE

Figure 3 presents the measles admissions to the Lagos IDH between January 1967-March 1969. As the campaign reached the residential areas near the IDH during August, September and October 1967, (four week periods 9 through 11), there was a striking fall in the number of measles admissions.

However, in February 1968, the number of measles cases began to increase and investigation of all cases admitted to the Lagos IDH was undertaken. Information on age, sex, and history of immunization were recorded by hospital personnel on a standard form.

The results of 434 measles case investigations are summarized in Table 2.

Table 2

Measles Case Investigations at Lagos Infectious Disease Hospital

Classification of Patients	Number of cases	% of cases
Non-participants in mass campaign	250	57.5
Too young for measles vaccine at time of mass campaign	94	21.7
Measles within 10 days after immunization	16	3.7
Measles 10 days or more after measles immunization	72	16.6
Not measles	2	0.5
Total	434	100.0

The 15 cases of measles occurring within 10 days after immunization probably represent pre-immunization exposure or possibly vaccine reaction. The 72 cases occurring post measles immunization were investigated further. Complete information was available on 66 cases. Figure 4 presents data on the age of immunization of these cases.

There is a clustering of cases in infants who were immunized during the second through the ninth month of life. This is the period when maternal antibody is still present, though decreasing, and cases in this age group are undoubtedly due to inactivation of the injected vaccine by maternal antibody. Interference by maternal antibodies is frequent under six months, and such children should not have been vaccinated. Cases in children six to nine months old represent a very small fraction of the population in that age group. Failures in this group probably represent late interference through maternal antibody. The remaining 16 cases must be classified as programme failures. Analysis of these 16 cases failed to reveal any clustering by time or vaccination site. Such a clustering would have been expected if there had been technical failure. If one accepts a 95% efficacy for measles vaccine as administered, the ratio of immunized to non-immunized children in a population in which coverage was 90% should be 0.45. In this study the ratio is 0.29 which estimates a programme efficacy of 97%.

MEASLES MAINTENANCE

In Lagos, (Lagos City and Lagos Urban), with a population of about 800,000, it is estimated that new susceptibles enter the population at a rate of approximately 4% per year or 3,000 per month. Effective measles control will require the identification and immunization of this population before the age at which the child is infected with wild measles virus. Two repeat mass campaigns have been carried out in Lagos City. The effects of these campaigns on measles cases and the pool of susceptible children are presented in Figure 5.

The maintenance programmes as administered did not control measles nor did it reduce the number of susceptibles to a level at which there was a great reduction in transmission. As a guess we estimate that the susceptible pool must be kept below 10,000 to achieve an acceptable level of control. Although it was possible to achieve this level with the mass campaign, maintenance of such a level will require a continuing programme of measles immunization. Currently in Lagos City six clinics are routinely providing measles vaccine at Child Welfare Clinics three times a week. If such a programme can be expanded to Lagos Urban, it is hoped that a better degree of measles control can be achieved in the future.

SUMMARY

In Lagos, measles is a disease of infants and young children with 36% of cases occurring in children under one. During a mass measles campaign 90% of the target population was immunized. Follow-up investigation of measles cases occurring after the campaign showed that 80% of cases were in non-immunized children. Of the remainder, 15% represent vaccine failure due to maternal antibody interference and 5% must be classified as programme failures. The overall efficacy of the measles programme, as administered, is estimated to be 97%.

FIGURE 1
AGE DISTRIBUTION OF 10,178 MEASLES PATIENTS
ADMITTED TO IDH – LAGOS, NIGERIA – 1965-1967

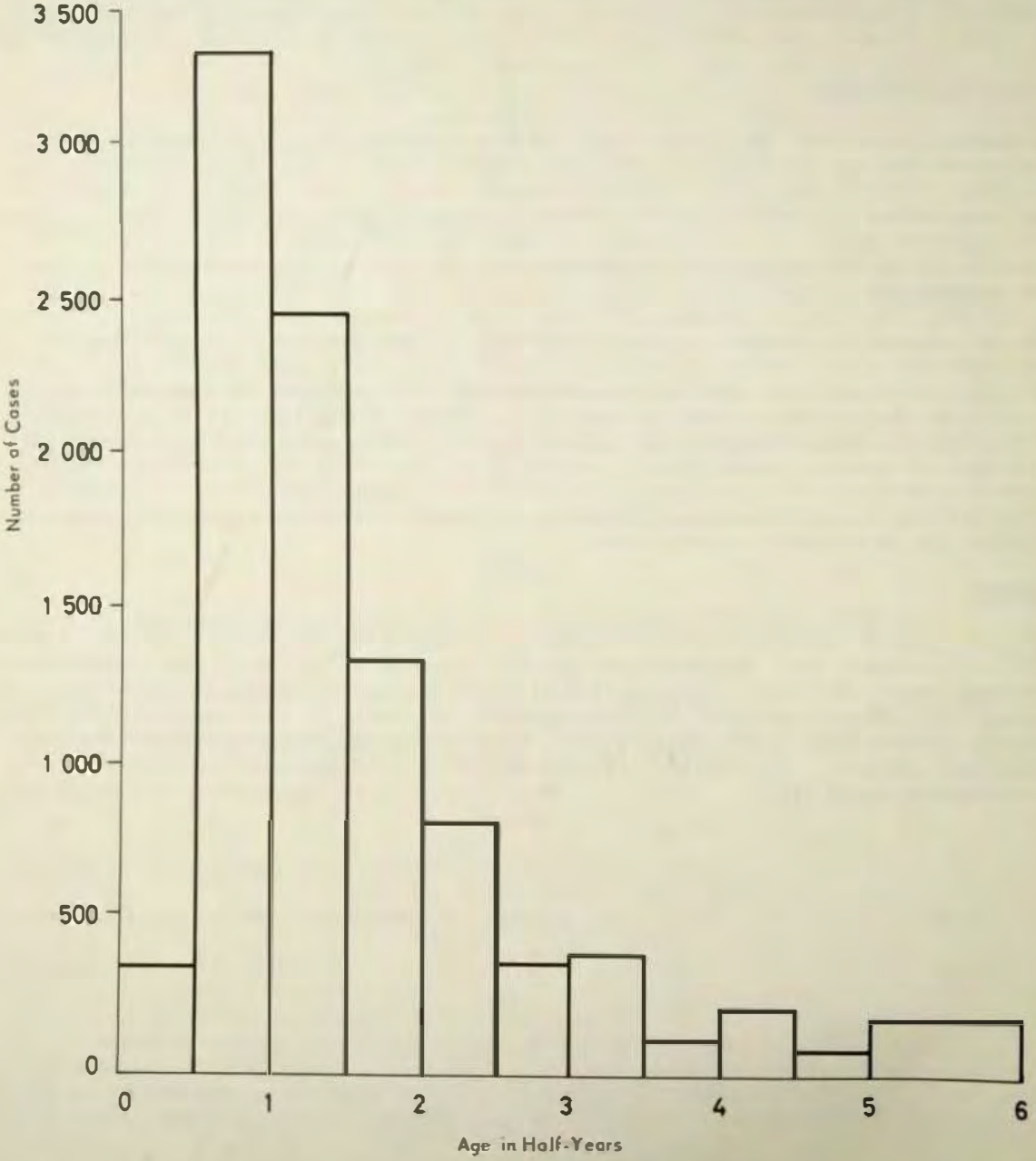


FIGURE 2
NUMBER OF MEASLES CASES ADMITTED TO IDH
LAGOS, NIGERIA – 1965-1966

FIGURE 3
NUMBER OF MEASLES CASES ADMITTED TO IDH
LAGOS, NIGERIA - JANUARY 1967 TO MARCH 1969

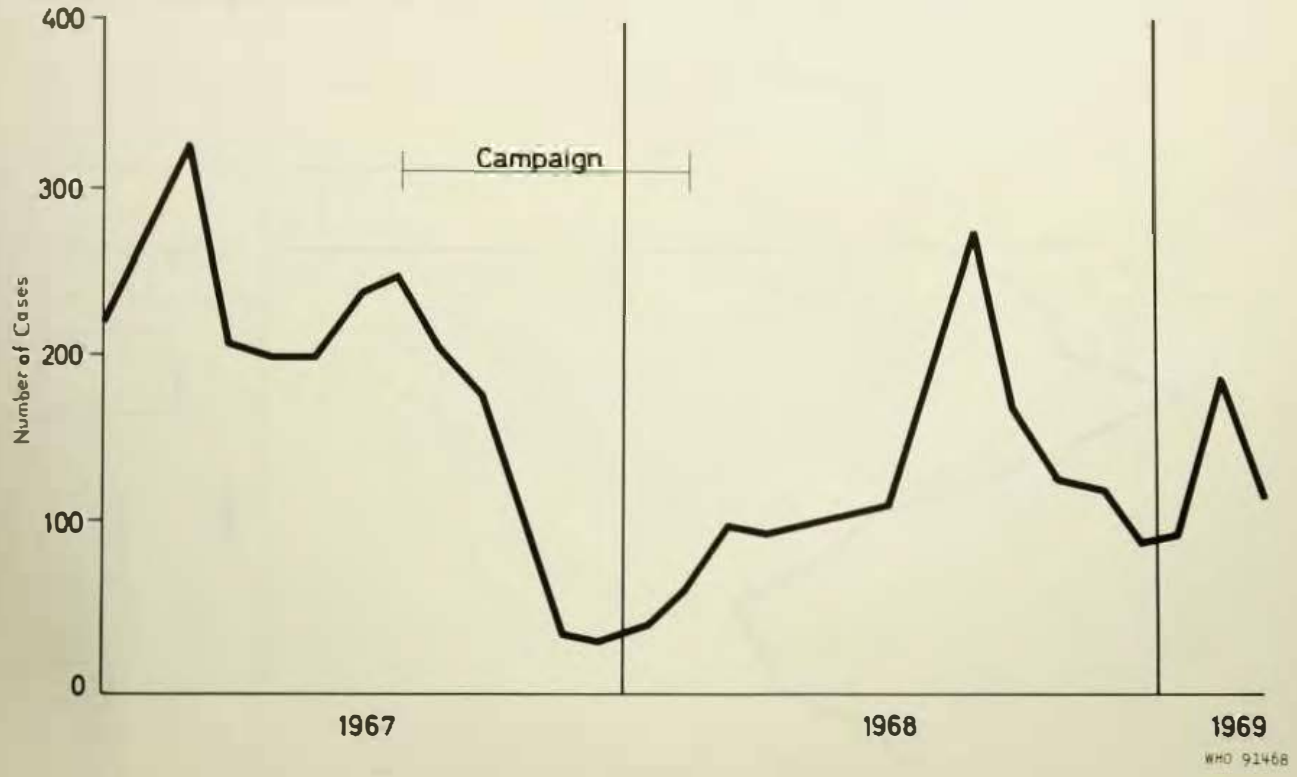


FIGURE 4
MEASLES CASES IN VACCINATED CHILDREN BY
AGE AT TIME OF IMMUNIZATION

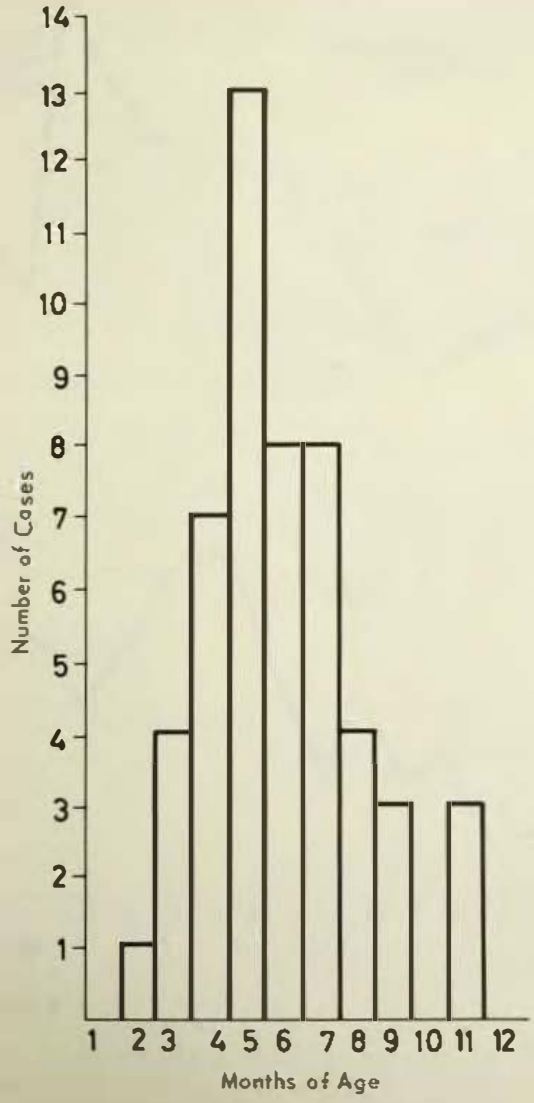
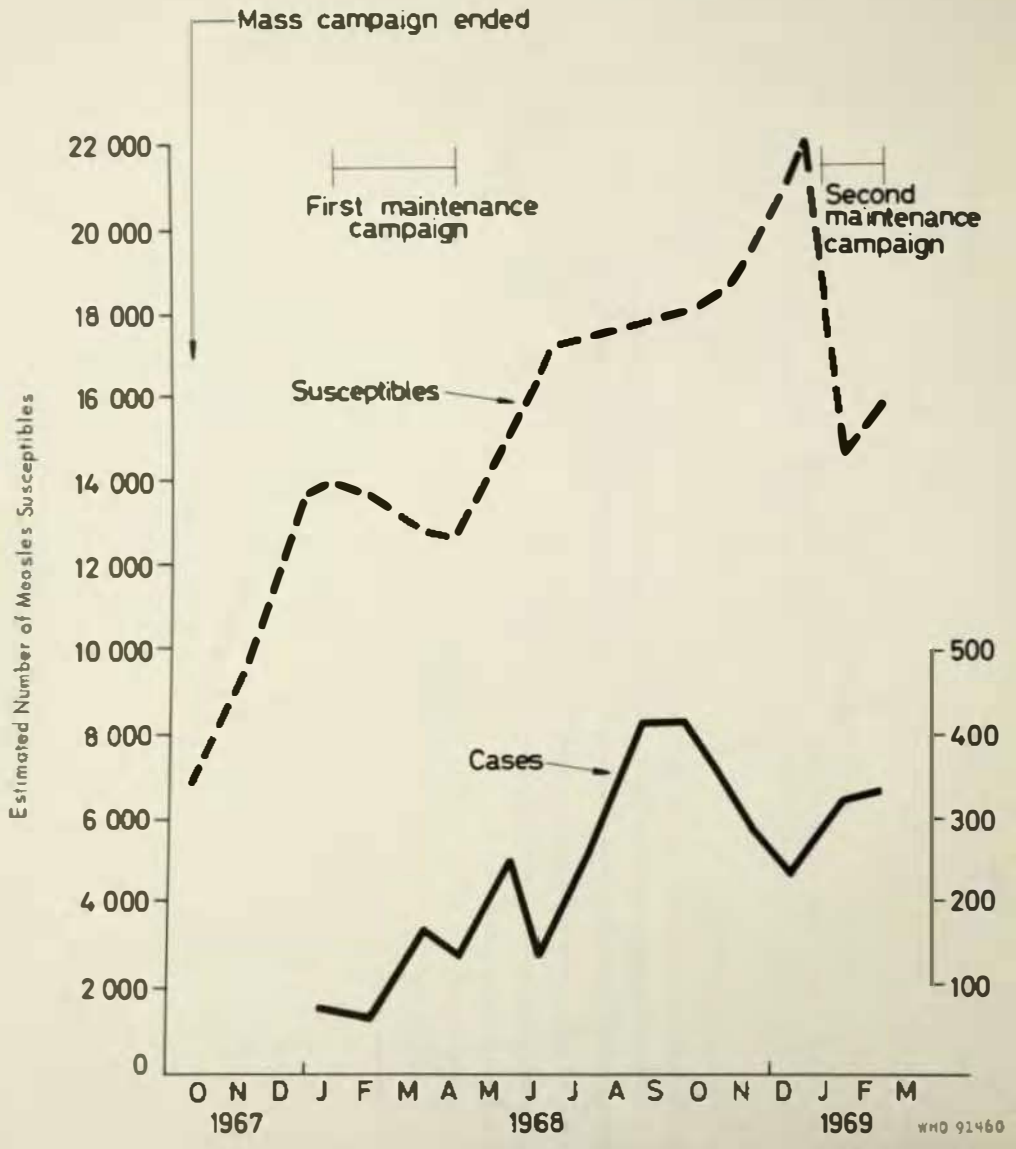


FIGURE 5
MEASLES SUSCEPTIBLES AND MEASLES CASES IN LAGOS
BY MONTH, OCTOBER 1967 TO MARCH 1969



MEASLES EPIDEMIC NEAR SALO, CENTRAL AFRICAN REPUBLIC

B. Durand[1]

Introduction

A measles epidemic with an unusual age distribution, unlike that which has occurred in other African countries, occurred in October 1967 in a group of seven small villages (the "groupement Kouapouli") in the extreme southwest tip of the Central African Republic near the borders of Cameroon and the Republic of Congo.

The village of Salo (population 1,000) located on the Sangha River is 10 kilometres from the closest of the Kouapouli villages and a coffee plantation is located equally distant between the two. The Kouapouli villagers generally have little contact with the Salo inhabitants or with the nearby Sangha River traffic. Many of the villagers sell food to workers on the coffee plantation, where they sometimes take temporary jobs during the harvest season. On occasion, they trade with some Pygmy villagers from the nearby forest. Otherwise, they maintain a traditional livelihood through food gathering and hunting.

The Epidemic

Information that a major measles epidemic was in progress in Kouapouli was first received by the C.A.R. Serivce des Grandes Endemies on October 17, 1967. On October 18, an investigation in Salo revealed many sick children. The next day in Adibori, 50 children from the Kouapouli area were diagnosed as having measles. It was learned that the first measles case in the area occurred in late August in the village of M'Boli. During September, the number of measles cases increased slowly throughout the seven villages before reaching epidemic proportions in October.

Vaccinations and Epidemic Control Activities

Plans for organizing a special measles vaccination programme for the sous prefecture of Nola were initiated immediately. Epidemic control vaccinations began on October 24. By October 29, a total of 2,248 vaccinations had been given throughout the Nola sous prefecture. In Salo, the target population included all possible susceptibles between the ages of six months and ten years. Of the 442 children from the Kouapouli area 307 of them had already contracted measles. Of the 135 remaining susceptibles, 105 were vaccinated.

Epidemiological Investigation

On November 11, a house-by-house investigation was made of 150 families with children in the Kouapouli area. Practically all children up to age 15 years were seen. Age was determined by birth certificates and other information provided by the villagers and by an African nurse. One measles case, a 25-year old female, is excluded from all tables.

A total of 510 children were seen (table 1). Among these, 318 children (62.4%) had contracted measles including two children from the Pygmy village (population 32) who became infected after measles appeared among the Kouapouli children. Of the 318 measles cases, 58 (18.2%) occurred in children between 7 and 15 years of age. Of 20 children under six months of age, two children were infected. Similar attack rates were observed for males and females.

A total of 21 deaths occurred among the infected children; all were younger than six years of age. Among those less than 6 months of age, two children were infected, one of whom died. The overall case fatality ratio was 6.6%.

[1]Directeur de Service des Grandes Endemies, Central African Republic

Table 2 presents measles case rates for the seven villages. All rates are high although there is wide variation from village to village. These rates vary from 44 cases per 100 children in M'Boli, to 93 cases per 100 children in Mekanda. By sex they vary from 51 cases per 100 males in M'Boli to 100 per 100 males in Mekanda.

Among the 150 families investigated, 81 had two children or more who contracted measles during the epidemic. In 56 of these families (69%) the oldest child was first to be infected.

Discussion

The source of infection for the Kouapouli epidemic was probably the families of the coffee plantation workers, who constitute the most frequent "outside" contact for the villagers. These workers come from as far away as the Chad border. They work for a few weeks or months before returning home or leaving for diamond prospecting in regions to the north. They are constantly replaced by other workers and their families. Plantation workers have been recruited steadily into the area over the past 40 years and provide a continuing potential source for the importation of measles.

In view of this constant possibility for exposure to measles, it is surprising that measles in Kouapouli had not occurred with greater frequency and consequent lesser intensity. The coffee plantation manager had observed no such outbreaks for the ten years he had been in the area and a missionary who had been working in the Nola sous prefecture for several years had witnessed no such outbreaks.

Conclusion

In Kouapouli, the reservoir of susceptibles that had built up over the years was unusually large. The fact that attack rates of over 80% were observed in children up to six years of age showed that measles had been absent or virtually absent from the area at least 6 years. In West Africa as a whole, measles epidemics are characteristically spaced no more than three years apart, and the cases are concentrated in the younger age groups, because most of the older children are immune as a result of infection.

Three-fourths of the measles deaths occurred in children under the age of three years. The highest case fatality ratios were reported in children aged two years or younger. This is consistent with findings throughout the other West African countries.

Table 1. Kouapouli Measles Epidemic

Age	Number of children seen	Number of Measles cases	Percent of cases by age	Cum. %	Attack rates %
6 months	20	2	0.6	0.6	10.0
6 months-1 year	14	9	2.8	3.5	64.3
1 year	32	28	9.8	12.3	87.5
2 years	57	51	16.0	28.3	89.5
3 years	53	45	14.2	42.5	84.9
4 years	62	53	16.7	59.1	85.6
5 years	43	56	11.3	70.4	80.0
6 years	44	36	11.3	81.8	81.8
7 years	40	22	8.9	88.7	55.0
8 years	28	6	1.9	90.6	26.1
9 years	27	12	3.8	34.3	44.4
10 years	25	7	2.2	96.5	28.0
11-15 years	68	11	3.5	100.0	16.2
Total	510	318			62.4

Table 2. Measles Attack rates by Village

Village	Children Seen*			Measles Cases			Attack Rate (%)
	M	F	T	M	F	T	
Adebori	63	55	120	44	31	35	62.5
Pygmy village	3	3	6	2	0	2	33.3
Bandoka	56	66	122	31	37	68	55.7
Satouba	19	17	36	13	12	25	69.6
Lobi	31	30	61	18	19	37	60.7
M'Boli	33	28	61	17	10	27	44.3
Mekanda	19	22	41	19	19	38	92.7
Motao	29	34	63	19	27	46	73.0
Total	255	255	510	163	155	318	62.4

*Virtually all children from 0-15 years were seen.

MEASLES IN AREAS OF MALNUTRITION

E. A. Smith[1]
S. O. Foster[2]

Measles is a major cause of morbidity and mortality among Nigerian children. In a longitudinal study at Imesi in Western Nigeria, Morley documented 15 measles associated deaths among 222 children with measles, a mortality ratio of 7%. Investigation of individual outbreaks of measles have shown a range of measles associated mortality of 1% to 40%.

The relationship between measles and malnutrition is complex. Many studies have been directed at defining the nutritional changes following measles. Considerably less information is available on the effect of nutrition at the time of infection on the morbidity and mortality of measles. With measles, weight loss is commonly seen. In the Imesi study 24% of children showed a weight loss of 10% or more. In this same study the mean time to recover pre-infection weight was 7.2 weeks. Nutritional studies in children after measles have shown a marked negative nitrogen balance. The practice of restricting protein in children who have measles, a common practice in Nigeria, further accentuates this negative nitrogen balance. The development of Kwashiorkor is commonly seen in the post-measles child. In the Imesi study, 9 of 222 children (4%) developed Kwashiorkor.

MALNUTRITION

As an increased measles mortality has often been associated with severe malnutrition, the great risk of measles to malnourished children in the liberated areas of the Eastern States was realized by the Federal Ministry of Health. In these areas, where agriculture, markets, and community organization had been disrupted by the war, 20-50% of newly liberated children showed clinical signs of malnutrition. In a survey by Foege and Conrad, 1297 new refugees near Ikot Ibritam of the South Eastern State were screened for malnutrition on a height/weight basis. As defined by their criteria, malnutrition rates in different age groups were as shown below.

Table 1: Percent of persons with malnutrition by age group in South East State

Age Group	Percent with Malnutrition
0-4	50
5-14	11
15-44	6
45+	28

Clinical examination of this group revealed an additional 10% of children to be malnourished.

MEASLES

The Eastern States have a definite seasonal pattern of measles occurrence with an increased incidence during the dry season, October to March. Major measles outbreaks have occurred every two years with peaks in 1964 and 1966. (Figure 1)

From the best available information, 1968 was not a major epidemic year and it is postulated that the disruption had decreased the frequency of measles transmission and thus prevented development of the predicted seasonal epidemic. As little measles was seen from July to October in the liberated areas, it is also possible that there

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[2]Medical Officer Adviser, NCDC/USAID, Lagos, Nigeria

had been a major interruption in the endemic transmission of measles as well. Thus in October of 1968, a large number of susceptible children, many of whom had malnutrition, were at risk of significant morbidity and mortality from measles. This risk was clearly demonstrated at Ikot Ibritam, where the introduction of measles into a Kwashiorkor treatment centre resulted in a mortality of 50%. Two programmes, a measles immunization campaign, and a surveillance programme were implemented as a co-operative effort of the Federal Government, the State Governments and Voluntary Agencies.

MEASLES CAMPAIGN

Measles/Smallpox teams were organized and trained in each of the 3 Eastern States. In some areas the immunization programme was directed solely at the measles susceptible age group. Children were given measles and smallpox vaccine simultaneously. Because complete coverage could not be achieved before the measles season, the following set of priorities was established.

1. areas reporting measles through the surveillance system
2. areas of refugee concentration (refugee camps, feeding centres)
3. areas with high rates of malnutrition.
4. systematic coverage of the population.

The difficulties of organizing a campaign in areas where the normal channels of communication were completely disrupted cannot be over-emphasized. Reaching the "floating" refugee population was most difficult, and combining it with food distribution was not always successful. Immunization of new refugee populations as they were screened for food distribution cards was more effective. It is estimated that approximately 300,000 children were immunized against measles by March 31 of this year. This represents 60% of the target population in the priority areas. Although follow up was difficult, surveillance of children in an Uyo refugee camp failed to reveal any mortality from the simultaneous immunisation. The only complications noted were multiple primary takes in several children with scabies.

SURVEILLANCE SYSTEM

With the rapid movement in population, changes in local food supply, and threat of epidemic disease, a surveillance system was organized using the relief teams in the field. The system was established to provide weekly information on food distribution, the population receiving food and medical attention, data on communicable disease, (smallpox, measles, meningitis, and pertussis), and death rates. The surveillance system (1) identified areas of measles infection for immediate epidemic control; (2) established the occurrence of significant measles morbidity in children 4-6 years who were being excluded from the target population, (This finding resulted in their inclusion); and (3) monitored the effectiveness of the mass campaign.

RESULTS

Measles vaccine can effectively terminate epidemic measles at the village level. Figure 2 shows the number of reported cases of measles in the village of Ugbowo in the East Central State. This village had a population of 2,500. There were 142 cases with 11 deaths, a fatality rate of 7.7%.

The sharp drop in the epidemic curve following the institution of the immunization programme strongly suggests an effective measles campaign. Data from the Enugu Sector of the East Central State (Figure 3) shows a similar effect. In retrospect, it appears that measles control would have been more effective if initiated 6 weeks earlier.

The case fatality ratios observed in the Enugu sector were 4.9 to 7.7% which is similar to those reported previously from Nigeria. If pre-measles nutritional status is a major determinent of measles mortality, the mortality figures suggest that nutrition

in the Enugu sector was similar to that existing before the war. In a recent visit to the Enugu sector, Dr. Hendriskse observed that nutrition was similar to that in other parts of Nigeria.

The cumulated data on measles cases for the 3 Eastern States are presented in Figure 4- Except for the major outbreak of January 11, when nearly 1,000 cases were reported from the Itu sector of the South Eastern State, major outbreaks have been avoided. The regular reporting of a low number of cases from all of the 26 reporting senters indicates a continuing low level of transmission. This can probably be explained by the less than adequate coverage which, because of the difficulties in health education and communication has averaged an estimated 60 to 80%.

FIGURE 1
MEASLES IN EASTERN NIGERIA – 1964-1966

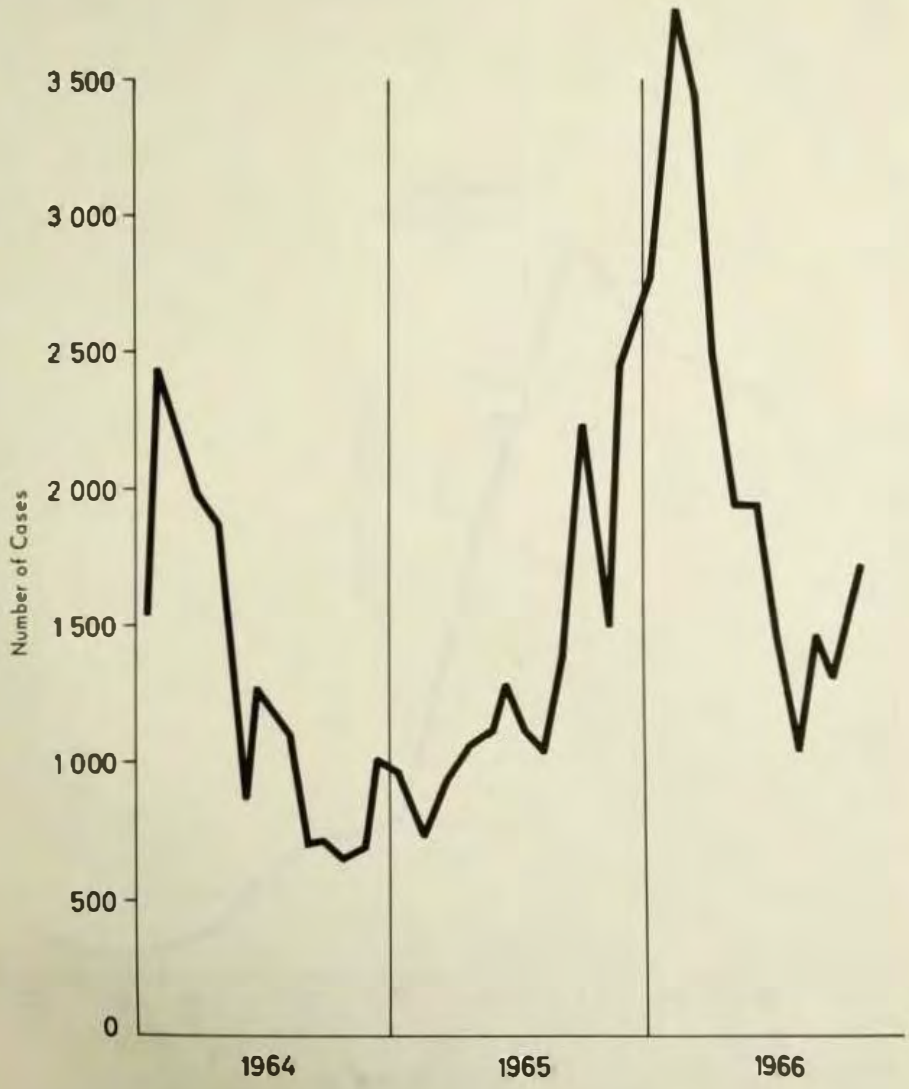

FIGURE 2
EFFECT OF MEASLES VACCINATION CAMPAIGN
ON EPIDEMIC IN UGBOWO VILLAGE

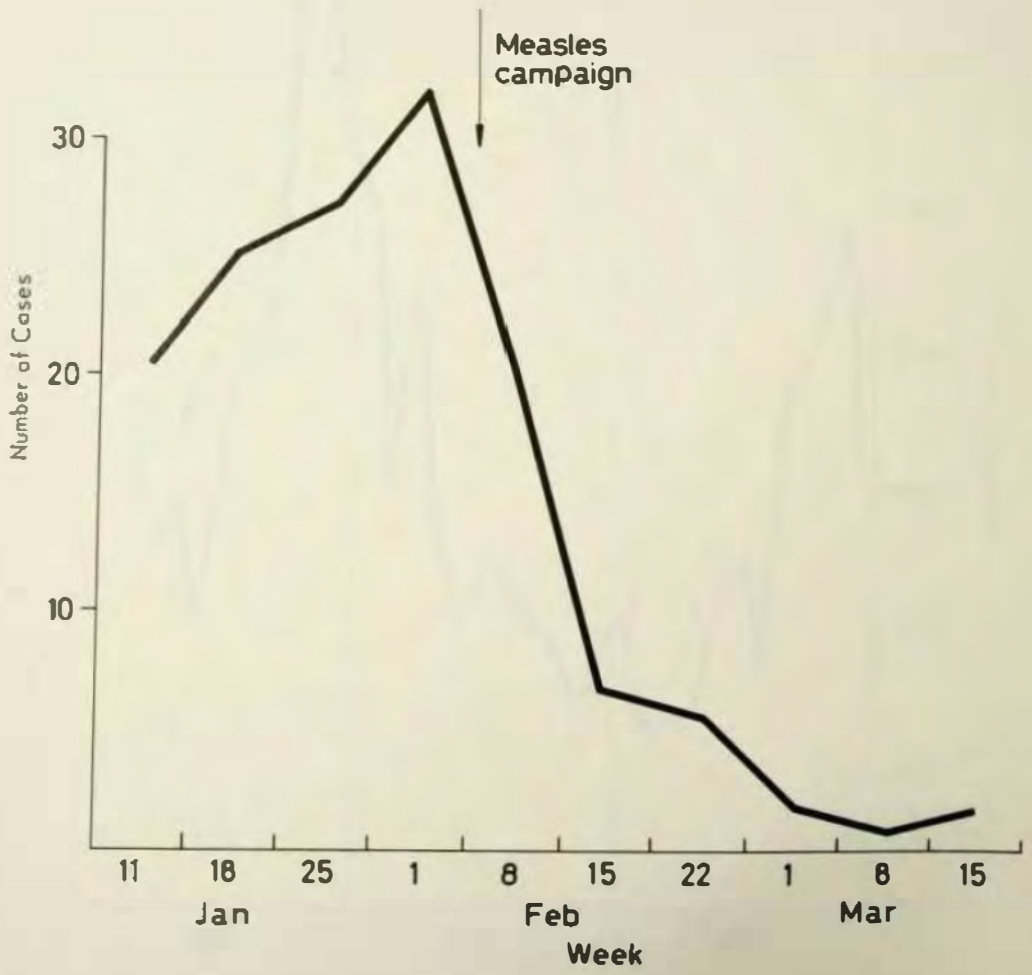

FIGURE 3
EFFECT OF MEASLES VACCINATION CAMPAIGN DURING
AN EPIDEMIC IN ENUGU CENTRAL STATE

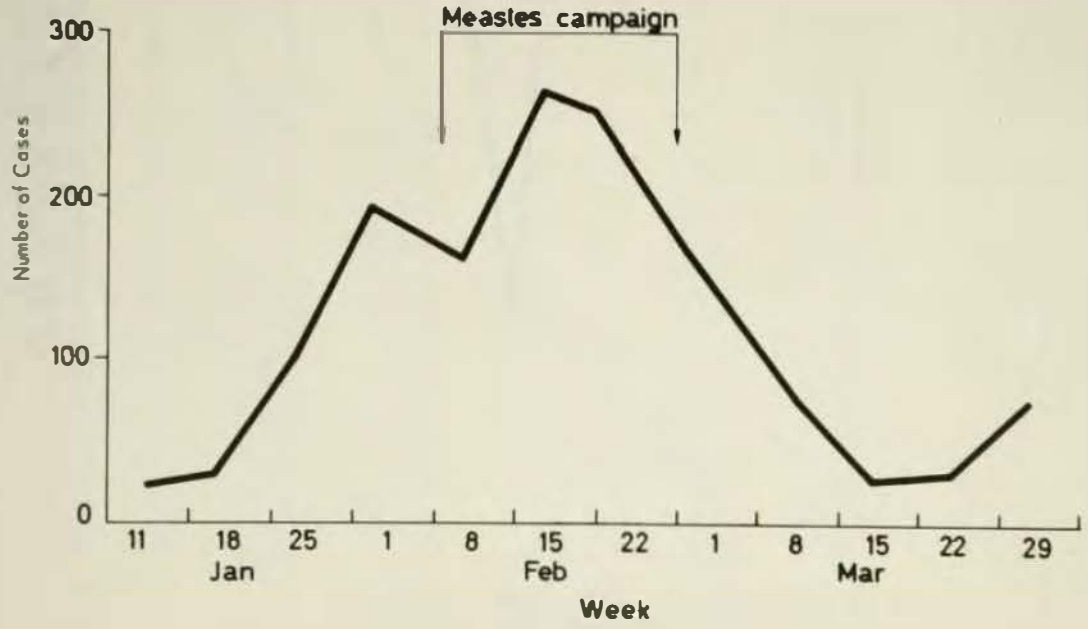

FIGURE 4
NUMBER OF CASES OF MEASLES IN EASTERN STATES
BY WEEKS - NOVEMBER 1968 TO APRIL 1969

A COMPARISON OF MEASLES VIRUS VACCINES

R. G. Hendrickse[1]

The measles vaccines currently in wide use in The Americas, Western Europe and Africa have all been derived from an attenuated variant of measles virus, first produced by Enders and his co-workers in the U.S.A., termed the "Edmonston Strain". Measles vaccines derived from other strains bave been developed and widely used in the U.S.S.R. and Japan but as these vaccines have had little application in Africa they will not be further considered.

The original Enders Edmonston B Strain vaccine was the first measles vaccine to be subjected to controlled clinical trials. Early trials in the U.S.A. and Africa confirmed that this attenuated measles virus vaccine was an effective immunising agent but concern soon arose about the frequency with which severe reactions occurred in the vaccinees[1]. In North America where measles is seldom a killing disease, it soon becomes apparent that both the medical profession and the general public were reluctant to accept a vaccination procedure with a predictably high frequency of severe febrile reactions.

In Africa and other developing areas of the world where measles is a major killer in childhood, the vaccine was more readily acceptable but some workers expressed grave reservations about the desirability of using a highly reactinogenic vaccine in communities where untoward reactions in malnourished children exposed to a host of endemic diseases might cause serious morbidity and possibly some mortality[2].

Notwithstanding these reservations, the attenuated Enders vaccine was increasingly widely used, and as early as 1962, some 730,000 children in Upper Volta were subjected to a mass vaccination program with the original Enders type vaccine[1].

Efforts were meanwhile being directed at modifying the vaccine, or the vaccination procedure, so as to reduce the severity of reactions while retaining its antigenic properties. Three approaches were adopted. (a) Attempts were made to produce a live, further attenuated vaccine of low reactinogenicity and high antigenity, (b) The use of killed measles virus vaccine was explored, and (c) simultaneous measles vaccination and gamma globulin administration was tried.

The last mentioned procedure was soon shown to be a very satisfactory method for measles immunisation. Reactions to the vaccination procedure were in general very much milder than with the Enders vaccine alone and antibody responses were entirely satisfactory.

The use of this method of vaccination on a wide scale in developing countries was however precluded because of limited supplies of gamma globulin, high costs, and logistical problems related to the administration of gamma globulin in correct dosage simultaneously with measles vaccine[3].

The use of killed measles vaccine was explored and found to be unsuitable for the following reasons:

(a) A minimum of two doses of killed vaccine are required to provoke detectable antibodies and even after 3 doses antibody levels are poorly maintained and vaccinees become susceptable to measles within a year or two.

(b) Subjects who receive killed vaccine are prone to develop a hypersensitivity type reaction to subsequent live measles vaccination or natural measles [4].

In view of these considerations, the use of killed measles vaccine has been abandoned and the subject is now only of historical interest.

[1]Professor of Pediatrics Head of Department of Pediatrics, University College Hospital, Ibadan, Nigeria

Further Attenuated Measles Vaccines

In the early 1960's intensive efforts were directed at producing further attenuated measles vaccines. Clinical trials were undertaken in a number of countries on new further attenuated measles vaccines as they became available, and countries in Africa, including Nigeria, made significant contributions to the development of further attenuated measles vaccines[3,5,6,7]. The first further attenuated measles vaccine to become widely available was the Schwartz vaccine, derived from the original Enders Edmonston A Strain, which was produced in the U.S.A. This was followed by the Beckenham 31 vaccine, produced in the U.K., which was derived from the original Enders Edmonston B strain[1]. Both these vaccines were subjected to extensive field trials in a number of countries and their properties compared with those of the attenuated Enders vaccine. Results of all trials confirmed the following points.

(a) The further attenuated Schwartz and Beckenham 31 vaccines cause significantly fewer severe febrile responses (103 F. or more), measles like rashes and general illness than the attenuated measles vaccines.

(b) The further attenuated vaccines give reaction rates similar to those recorded when the attenuated Enders B vaccine is given with gamma globulin.

(c) The serological conversion rates with the further attenuated vaccines are entirely similar to those achieved with the Attenuated Measles Vaccines and there is substantial evidence to show that protective antibodies persist for at least 7 years and may possibly persist for life.

Direct comparison of Schwartz and Beckenham 31 further attenuated measles vaccines has been undertaken in several countries including Nigeria, Iran and Hong Kong. These studies indicate that the two vaccines are very similar in their general behaviour. Such slight differences that have emerged from these studies suggest that the Beckenham 31 vaccine is slightly more reactinogenic and antigenic than the Schwartz vaccine.

Conclusions.

The further attenuated measles vaccines have been shown to be effective immunizing agents capable of affording long, possibly permanent, immunity against measles; the level of protection they afford is entirely similar to that afforded by the original Enders attenuated vaccine while the clinical response to vaccination is significantly milder. In the light of these facts, there can be no reasonable justification for the continued use of the attenuated Enders type measles vaccine, especially in situations where the child population is exposed to the ravages of malnutrition and serious endemic infections which might predispose them to serious untoward effects of measles vaccination.

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Measles Vaccination with Reduced Dosage*

R. G. Hendrickse[1]

INTRODUCTION

Widespread immunisation against measles is currently being undertaken in many developing countries with outside financial assistance. The health authorities in these countries will eventually be faced with the problem of maintaining the immunity status of their child populations once the assisted schemes come to an end.

Measles vaccine is expensive even when administered to relatively large groups of children and multidose containers are used. Containers for single or small numbers of doses are relatively more expensive, since a fairly large proportion of the total cost is absorbed in ampouling. This high cost of measles vaccine is likely to present serious problems in many areas and may deter authorities from using the vaccine (Cooper et al., 1966). If adequate immunization was achieved with a lower dose of vaccine than is currently being used, there could be a significant reduction in the cost.

It is well known that small doses of attenuated or "further attenuated" measles virus can produce infection in susceptible individuals. Karelitz et al. (1961) showed that 100 $TCID_{50}$ of attenuated virus, as assayed in tissue culture, would infect human subjects. Rey et al. (1965) obtained 95% sero-conversion rate with 100 $TCID_{50}$ of Schwarz further-attenuated vaccine, and Cooper et al. (1966) quote a personal communication from Dr. Schwarz indicating that as little as 10 $TCID_{50}$ of this vaccine, given by syringe and needle, will infect.

Hendrickse et al. (1966) noted that doses of approximately 30 $TCID_{50}$ of Leningrad 16 measles vaccines, as titrated in Hep-2 cells, produced a 78% sero-conversion rate when given by syringe and needle to a small group of children. The same group of workers (Hendrickse et al., 1967) reported promising results when small doses of further-attenuated vaccine were given by Dermojet; the disadvantage of this apparatus is that only about 0.07 ml. is delivered, and sometimes it is obvious that a substantial proportion of the dose remains on the skin. A similar observation was made by Calafiore et al. (1968), who showed that the efficacy of Schwarz vaccine was dependent not only on the dose administered in terms of $TCID_{50}$ content but also on the volume of fluid in which the virus was injected. These workers suggested that small infective doses might be satisfactory when given in a relatively large volume, but that until this had been demonstrated 1,000 $TCID_{50}$ should be retained as the standard dose.

It seemed worthwhile, therefore, to investigate the immunizing potential of reduced doses of measles vaccine administered by the same technique and under similar field conditions to those obtaining in most countries where mass vaccination campaigns are currently in progress.

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*Based on a publication by R.G. Hendrickse and D. Montefiore "Measles Vaccination with Reduced Dosage", Brit. Med. J., 4, 28-30, 1968.

[1]Professor of Pediatrics, Head of Department of Pediatrics, University College Hospital, Ibadan, Nigeria

CLINICAL TRIAL

Vaccination was offered for children aged 6 months to 3 years living in a rural area of Kwara State, Nigeria. A small number who were younger than these also attended, and there were also a few who were up to 4 years old.

After registration the first 191 children had pre-vaccination blood samples taken: these were obtained by finger-prick, and the sample was absorbed on to numbered filter-paper discs which contained 0.2 ml. of blood when fully saturated. The rest of the children attending were vaccinated(see below) but no pre-vaccination blood samples were taken.

After vaccination each child was given a suitable dose of pyrimethamine to prevent any attack of malaria during the period when vaccination reactions might be expected, and was told to return to the clinic in four weeks' time, bringing the duplicate registration card. Post-vaccination finger-prick blood samples were taken from all children who had been bled initially and who returned for the second visit. Some additional post-vaccination blood samples were obtained from children who were not bled initially.

VACCINE AND ADMINISTRATION

Beckenham 31 strain measles vaccine (Wellcovax) was used. This was supplied as a lyophilized material of known viral content, which was reconstituted with distilled water immediately before the vaccination session began. Initial reconstitution yielded a suspension containing 1,000 $TCID_{50}$ virus per 0.5 ml. Further dilutions were made in distilled water to yield suspensions containing 330 $TCID_{50}$ and 200 $TCID_{50}$ per 0.5 ml. These dilutions were stored in a vacuum flask at 4°C. until used. Bleeding and vaccinating the children took a little over four hours: at the end of the session the remaining vaccine dilutions were returned, at 4°C., to the laboratory for check titration. They reached the laboratory about seven hours later, and were then frozen at -40°C. until titrated; the titration values obtained showed that there had been no loss in potency from the calculated values as a result of these procedures.

RESULTS

Over half the children were already immune to measles by the age of 3 years, and over half the children under 8 months old were also immune, in this case probably largely due to the presence of maternal antibodies. (The best age for measles vaccination in this community would therefore appear to be between 8 and 24 months of age.)

POST-VACCINATION IMMUNITY

Satisfactory paired blood samples were obtained from a total of 129 children.

There was an apparently low sero-conversion rate among the children aged 3 to 7 months given 200 $TCID_{50}$ virus. This was most probably due to a number of "non-converters" who appeared to be initially non-immune in fact, possessing titres of maternal antibodies which were too low to be detected by the laboratory methods used, but which were sufficient to inhibit multiplication of the vaccine virus. The % immune after vaccination was 94.8%.

The numbers of children in the 330 and 1,000 $TCID_{50}$ groups are very small, but when all age groups, with the exception of those aged 3 to 7 months were combined, little difference was apparent in the serological responses to the differing dose levels. The percentage immune was 95% and 100% respectively.

Post-vaccination blood samples only were only available from 37 of the children given 160 $TCID_{50}$ vaccine. The percentage immune was 87%. Though the numbers were small

there appeared to be no significant difference in the proportion of children serologically immune four weeks after receiving any of the doses of vaccine used. This would suggest that serological conversion rates are satisfactory even with the lowest doses of vaccine used, and would thus indicate that there is a reasonable margin of safety with 200 $TCID_{50}$.

CONCLUSION

While it may be desirable to confirm these results with other vaccine preparations, it would seem that the way is open for a considerable reduction in the cost per dose of measles vaccine, especially when used on a scale large enough to justify the use of multidose containers.

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SURVEILLANCE

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SMALLPOX SURVEILLANCE IN THE STRATEGY OF GLOBAL ERADICATION

D. A. Henderson[1]

Smallpox surveillance represents the single most important component of the present global eradication effort. In fact, the ultimate success or failure of the eradication programme depends principally upon our capability to develop an effective surveillance system in each country and on a global basis. It is only within the past three years, however, that this has been fully appreciated.

In the past, a programme of smallpox eradication was considered to be synonymous with a mass vaccination campaign. Originally, national programmes were so designed. Some were effective but many were not. When it became apparent that mass vaccination alone was often unsuccessful, programmes were enjoined to increase their targets for vaccination coverage from 80% to 100%[1]. The actual objective of the programme, "the eradication of smallpox" was obscured by an alternative goal, "vaccination of 100% of the population".

While total vaccination of the entire population is a worthy objective and, if successful, would assure eradication of smallpox, such coverage is logistically and practically impossible. In fact, as efforts are made to increase vaccination coverage beyond 80% to 85%, the costs and difficulties increase logarithmically while immunity levels increase arithmetically. Even with 90% of the population vaccinated, smallpox transmission may still persist. On the other hand, it is known that some countries have become smallpox-free at a time when much less than 80% of their populations have been vaccinated. It is thus more logical to consider the strategy of smallpox eradication in terms of the actual objective, "eradication of smallpox", and to determine how best to interrupt transmission of the disease rather than to pursue blindly a simple programme of mass vaccination.

The most direct approach to eradication is to interrupt transmission of smallpox through the containment of outbreaks. We know that focal outbreaks of smallpox can be rapidly and effectively controlled. Even in countries such as Ceylon or the United Kingdom, for example, where immunity levels are actually poorer than in most presently endemic countries, outbreaks have been rapidly terminated by comparatively limited but specific containment measures. The explanation is simple. When a country becomes smallpox-free, the occurrence of a single suspect case is usually cause for alarm and the problem is dealt with as a public health emergency. Containment of the outbreak, especially at an early stage, is really not difficult. In endemic countries, however, health authorities and indeed the population as a whole frequently have come to regard the disease as an inevitable occurrence; the various sites which could report cases often do not do so or they report only after a long delay. This is not surprising for, until surveillance-containment programmes have been developed, there is little motivation to report cases. Rarely is help provided to deal with outbreaks and thus there is no reason to report. By the time the problem is recognized, the outbreak has spread throughout one or more health jurisdictions and sometimes to other areas. Of course, if the population has a high level of immunity, transmission will proceed more slowly and an outbreak, even though detected only after many weeks, may be reasonably readily contained. If there is a very low level of immunity, however, the disease may spread more rapidly and containment procedures are less likely to be successful.

As we consider the strategy of the global eradication programme, it is useful to keep these points in mind and to recognize, first, that the objective of the programme is to interrupt the transmission of smallpox; second, that the most direct way to interrupt the transmission is to detect and contain outbreaks of the diaease; and, third, that the systematic programmes of vaccination, while unquestionably important, are basically to facilitate the execution of surveillance-containment operations.

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Least developed, and in some countries, virtually non-existent at the beginning of the global eradication programme was the most important component - surveillance. It is well to recall that the surveillance of smallpox is probably easier than for any other communicable disease. In smallpox, the infected person develops a distinctive rash which is wholly characteristic in the great majority of cases[2]; the rash is most dense over the face and hands, the unclothed readily visible portions of the body; persons with subclinical infections are rare and are of little importance since they do not appear to be able to transmit the disease to others[3]. In brief, the disease characteristics are such that there is little difficulty in detecting visually whether or not the virus is present in an area. The rash is sufficiently characteristic in the great majority of cases that laboratory confirmation is academic. In addition, in the instance of variola major, fully 75 per cent of cases are left with visible scars[4], most notable over the face. This permits us to appraise the extent of past infection by simple surveys which determine the prevalence of the characteristic facial scars. By relating these observations to the age of the individual, we can also ascertain the most recent period when infection was present. If, for example, a country believes itself to have been free of smallpox for 5 years and characteristic facial scars are observed in a 2 year old child, a detailed investigation would be warranted to determine by history whether or not the scars could have been caused by smallpox and, if so, where the infection occurred.

The first requisite in surveillance, identification of where the disease exists, is thus comparatively simple.

Additionally, smallpox has several epidemiological characteristics which, as a group, are unique. In brief, these are as follows:

1. Smallpox is transmitted solely from man to man. There are no known animal reservoirs; [2,5] insects appear to play no role.

2. Detection and recognition of the disease is a comparatively simple matter, as previously noted. Persons with subclinical infection are rare and of little importance epidemiologically since they do not appear to be able to transmit disease.

3. The infected individual is capable of transmitting infection during a comparatively brief period - from emergence of the first lesions until the scabs have fallen off - a period of about four weeks. Following infection, he has essentially permanent, lifetime immunity.

4. Transmission requires close contact between infected and susceptible individuals and most commonly occurs in the home, the hospital or school.

5. Epidemics develop comparatively slowly. Between each generation of cases, there is a period of two to three weeks. In most circumstances, the infected individual transmits disease to not more than 2 to 5 other persons.

It is precisely these characteristics which permit the surveillance activities in a smallpox eradication programme to be as highly effective and practicable as they are. The significance of these characteristics is better appreciated as one considers the manner in which the transmission of smallpox is sustained.

Since smallpox is transmitted solely from man to man and since the infected individual can only transmit the disease over a period of four weeks or less, it is apparent that a "chain of infection" is required if the disease is to remain endemic in an area. For smallpox to persist, an infected person with clinically apparent disease must infect a second person who similarly must develop clinically apparent

illness and so on to subsequent generations. Since there is a lapse of two to three weeks between generations of cases, we can by simple arithmetic determine that the most tenuous chain of transmission in a country requires that at least 15 to 25 cases occur annually. If fewer cases than this are recorded, only two explanations are possible: reporting is incomplete, or the cases represent reintroductions of smallpox. It is also apparent that when any country reaches the level of perhaps 200 to 500 cases in a year, there are few chains of infection extant and that fairly simple containment procedures should readily and rapidly be able to interrupt transmission.

Transmission most commonly occurs as a result of close contact as in a household, hospital or school. Contrary to common belief, casual contact as might occur in markets or on public transportation comparatively infrequently results in transmission. Noted below are four illustrative outbreaks.

Locale of infection	Locale of Infection of Cases in Five Outbreaks				
	United Kingdom 1961-1962	Sweden 1963[7]	Kuwait 1967[8]	Abakaliki Nigeria 1967[9]	Bawku Ghana 1967[10]
Imported	5	1	1	1	?2
Household (or compound)	17	13	1	30	58
Hospital and other medical	39	13	32	0	0
Market	0	0	0	1	3
Other & unexplained	6	0	8	0	5
	67	27	42	32	68

Despite the fact that in each of these outbreaks, there were a number of patients who were ambulatory following the onset of illness and in casual contact with many persons, comparatively few cases occurred which could not be readily traced to household or hospital contact. Often disregarded in the tracing of cases, the hospital can be an important source as illustrated in the first three outbreaks. Although in outbreaks cited above, contact in schools played no apparent role, studies in Brazil have shown that the schools may also be instrumental in some circumstances in disseminating infection throughout a community[11]. Since hospitals are few in number in endemic countries, it is evident that most individuals must acquire infection through household contact as, in fact, they do. Since the infected persons rarely transmits disease to more than 2 to 5 additional persons, the disease spreads comparatively slowly, usually among other household residents, neighbours and visiting relatives. Not unexpectedly, then, smallpox occurrence is characterized by highly localized focal outbreaks involving a comparatively few houses or a few villages in an area. This is quite the reverse of the common belief that when smallpox occurs in a country, it is a widely dispersed infection with single cases scattered over an extensive geographic area.

In this context, it is interesting to note recent observations in India and Pakistan, two countries which account for two-thirds or more of all recorded cases of smallpox. In Pakistan, during the course of one year, an intensive surveillance programme was conducted in a rural district of 1.2 million persons.[4]

During the period, 1,040 cases occurred, an incidence as high as that observed anywhere in the world. However, throughout the course of the entire year, only 170 of the 1,700 villages (10%) were infected with smallpox. In December 1967, an assessment survey in a highly endemic district of India,[12] similarly revealed that during the course of the year only 101 of 2,331 towns and villages were afflicted with smallpox.

At no time were more than 20 (1%) of the villages afflicted and, at the seasonal low point of smallpox, only seven villages recorded disease. Thus, even in these highly endemic areas, smallpox occurred not as a widely dispersed sporadic transmission. Prompt case investigation coupled with active efforts to trace infection sources and comparatively simple containment activities could have had a major impact on disease incidence and might well have terminated all transmission. One effective epidemiological team in each of these Districts could have dealt with the problem.

Vaccination programmes conducted during past years undoubtedly have had a decided influence in reducing the proportion of susceptibles and thus reducing the probability of further spread. Successful vaccination confers substantial protection for many years and undoubtedly is partially protective for at least 10 to 20 years. Although the duration of protection conferred by a single successful vaccination is unknown, recent data show almost universally that 85% to 95% or more of all cases have no scar of vaccination to confirm the fact that they had been successfully vaccinated. The impact of prior vaccination is most vividly illustrated by studies conducted by Rao and his colleagues in Madras.[13] They found that among 103 unvaccinated family contacts, 37% contracted the disease while among 1,108 who had at some time been vaccinated, only 1% contracted smallpox.

Frequency of smallpox among vaccinated and unvaccinated contacts - Madras[13]

Age	No. of unvaccinated* contacts	No of cases of smallpox	No of previously vaccinated contacts	No of cases of smallpox
0-4	57	23	118	0
5-14	18	4	287	2
15-44	15	9	543	10
45+	13	2	160	1
	103	38 (37%)	1,108	13 (1%)

*Unvaccinated at time of exposure.

Further, those previously vaccinated who did contract smallpox were far less effective in transmitting it than were those individuals who were unvaccinated.

Frequency of transmission from unvaccinated and previously vaccinated cases to vaccinated and unvaccinated contacts, Madras, India[13]

	Contacts					
	Vaccinated			Unvaccinated		
	No.	No. developing smallpox	%	No.	No. developing smallpox	%
Case - previously vaccinated	527	2	0.4	32	9	28
Case - unvaccinated	619	12	1.9	71	29	41

This observation is consistent with laboratory studies which have shown that the quantity of virus excreted by a patient correlates with the number of lesions present in the mouth.[14] Individuals who have previously been vaccinated tend to have fewer lesions both on the skin and on the mucous membranes and so excrete less virus and have greater difficulty in infecting others. Those with significantly attenuated illnesses and few lesions, the group which may be troublesome diagnostically are fortunately of less epidemiological significance for this reason.

As the unvaccinated play the major role in perpetuating smallpox transmission, the strategy of eradication campaigns bas focused particularly on identification of which groups are especially poorly vaccinated. The word "group" is stressed for it is obvious that unvaccinated individuals widely scattered throughout a well vaccinated community do not encounter sufficient susceptibles to sustain the chain of transmission of smallpox for very long and the disease soon dies out. A group of major concern in most countries are those in the lower socio-economic stratum in the cities and towns. Significant numbers in the lower socio-economic groups are poorly vaccinated migrants, often from rural areas, who enter the cities and settle among other migrants in densely crowded quarters. Smallpox is readily transmitted under such circumstances. As the migrants travel back to the rural areas, either permanently or to visit, they carry the disease with them. Vaccination programmes in urban areas have rarely in the past made provision for intensive and repeated vaccination campaigns in this highly mobile, rapidly changing group.

A second principal group of concern is children. In most countries, two-thirds or more of all cases occur among those less than 15 years of age. Several studies have shown that young children in particular are excellent vectors of the disease. As children tend to move more actively throughout a community than do their elders, they transmit infection more widely and often serve to transmit the disease between houses or compounds.

But, in countries with limited health facilities, how can a surveillance programme be expected to function? Repeatedly, we are told that medical personnel are nil, that there is no one who can report cases of smallpox and that there are great uncharted sparsely populated areas in which there are few or no government facilities at all. If we keep in mind certain of the characteristics of smallpox epidemiology which we have discussed and bear in mind that there must be a chain of transmission for the disease to sustain itself, the problem, as most of you know, is much less impossible than would first appear. In the least developed countries, one consistently finds a surprising number of widely distributed government and mission hospitals, aide posts and the like which regularly attend to persons who are ill. In several endemic countries, malaria workers visit all houses over vary large areas every 30 days. The first step, therefore in the surveillance operation is to identify those who can report suspect cases, to enlist their support and to promote regular and prompt reporting from each as to whether or not smallpox cases have been observed. Since in endemic areas, even the local populace is frequently astute in smallpox diagnosis, this simple network may be augmented by soliciting reports of suspect cases from schoolteachers, village development workers, village headmen, etc. At the same time, the reporting network is being set up, mobile investigation and outbreak containment teams are created. In highly endemic areas, one team may be required to cope with problems in a population area as small as perhaps 1 to 2 million persons. As incidence falls, one team may be sufficient for an areas encompassing 5 to 25 million persons. Such teams, by simply carrying out their responsibilities, demonstrate to all concerned that there is a reason to report cases - that action is taken on the basis of the reports received. Obviously all cases will not initially come to recognition. Outbreaks may occur in remote villages and be undetected. But, keeping in mind that for smallpox to persist as an endemic disease, an uninterrupted chain of infection is necessary, it is apparent that outbreaks in remote areas will either die out or come to recognition when the sources of infection of subsequent cases are sought. As noted previously, smallpox does not erupt as a sudden conflagration involving thousands of cases but, rather, outbreaks evolve comparatively slowly with intervals of two to three weeks between generations of cases and with comparatively few becoming infected from each successive case. Thuse, although four, five or six generations of cases are missed, an outbreak even at that point in time is numbered not in thousands but, at most, by a few hundreds of cases or less and is manageable by isolation, rapid widespread vaccination and tracing of infection sources.

Interruption in the chains of transmission of smallpox can occur very rapidly. The most notable example in the current eradication effort is that of your own countries in west and central Africa. When it is considered that the programme began less than three years ago and in some countries less than two years ago; when it is recalled that the population is 120 million persons distributed over an area larger than India or Brazil, with health services and medical resources substantially less than either country; when it is realized that immunization levels at the beginning of this programme were but a fraction of those presently observed in Asian countries, the reduction in smallpox incidence to virtually nil levels in this brief period is an amazing achievment. I am confident that your surveillance programme accounts, in major part, for this success.

Does this mean that every last person or every last village has been vaccinated? We know that they have not! But systematic vaccination has served to reduce transmission to the point where surveillance measures have been able to interrupt the chain of infection. Surveillance has been the specific, the definitive weapon in this campaign.

That surveillance is the key to the eradication programme is clear. Let me go one step further and say that if the responsible authorities in all endemic countries were to comprehend fully the importance of this measure and were to take definitive action along the lines noted, global smallpox eradication within a period of three years could be a practical reality.

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THE VALUE OF SURVEILLANCE NEWS LETTERS

E. A. Smith[1], S. O. Foster[2]

Surveillance is an integral part of an eradication programme, as the term eradication signifies that the number of indigenous cases of smallpox is zero. The surveillance system identifies and quantitates the existing disease problem and is essential to the planning and launching of a mass campaign. It identifies cases of disease within the population by age, sex, time and place. Surveillance data often permit factors influencing the transmission of disease to be identified and this, in turn, assists the implementation of effective control measures. Surveillance is essential to monitor the effectiveness of the eradication campaign and to identify importations so that eradication, once achieved, can be maintained.

Dissemination of surveillance data is an essential part of this system. This distribution of data has the following purposes:

1. It assures the reporting sites that their reports are looked at and are being used. This in itself is a positive stimulus to improved reporting.

2. It identifies disease problems both quantitatively and geographically so as to alert local health authorities of present or potential epidemic situations.

3. Through special reports, (which might be included in a Surveillance News Letter), examples may be presented of different types of investigation and control procedures which may assist local health authorities in improving their own methods of case investigation and control.

4. In an eradication campaign, a news letter keeps local health authorities informed of the planning, progress, and problems in the mass campaign. Such information maintains local interest and continually reminds local authorities of their specific responsibilities to ensure the success of the eradication campaign.

The Federal Headquarters should be responsible for a news letter which emphasizes the importance of surveillance in the control of diseases, especially communicable diseases. The news letter should show clearly the source of the reports and the routine collected data, including the age group, sex, location, number of cases and deaths, and the vaccination status of the area. Information based on the clinical diagnosis of disease should be accepted, altbough this may be modified at a later date on receipt of a laboratory diagnosis. The news letter should indicate clearly the total of the routinely reported cases, special field investigations, survey reports and relevant research information. The control measures and other operational procedures used in the country should be briefly mentioned. It should contain interpreted information that will show the disease situation in the country, and should be widely distributed within and outside the country.

The Nigerian Smallpox Measles Programme has experience with distribution of surveillance data in several forms:

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[1]Medical Director, Nigerian APE/MC Programme, Lagos, Nigeria

[2]Medical Officer Adviser, NCDC/USAID, Lagos, Nigeria

1. The Weekly Epidemiological Bulletin is an official ministry document tabulating disease reports as received. It is not a true news letter in that there is no narration or interpretation. Such a report is used to fulfill international requirements on disease reporting.

2. The Epidemiological Unit has prepared periodic, but quite lengthy, surveillance reports on the progress of smallpox measles campaign. These reports are very useful but the time for preparation and distribution is such that there is a 4-6 weeks delay in getting current data to the field. This delay in circulating current disease information lessens its effectiveness.

3. The Nigerian Programme is currently experimenting with a one page weekly Surveillance Bulletin (Annex 1) which is intended to provide disease information and interpretation on a current basis. Inclusion of such sheets with the Weekly Epidemiological Bulletin would solve many of the logistic problems of distribution.

4. In addition, the various Area Programmes in Nigeria have also used local surveillance news letters to provide local programme data.

In summary, the surveillance news letter serves as an integral part of disease surveillance by providing field personnel with current data; it improves coordination of control activities and stimulates reporting, investigation and control at the local level, which are essential to the achievement of disease eradication.

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GOVERNMENT OF NIGERIA
FEDERAL MINISTRY OF HEALTH, EPIDEMIOLOGICAL UNIT

Surveillance Bulletin Week Ending May 2, 1969

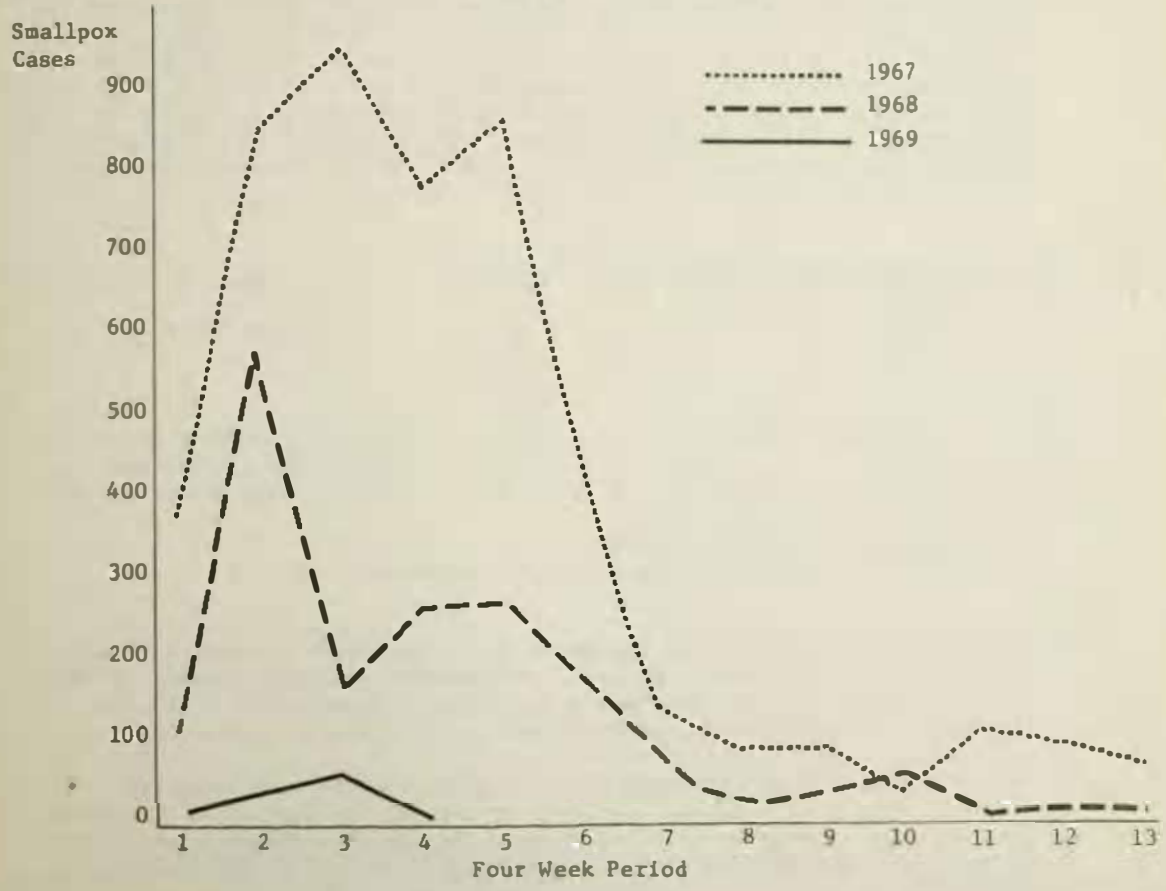
I. SMALLPOX

A. Official Reports

Only five cases of smallpox were reported during April. This low number of cases at the height of the epidemic season indicates great progress in the eradication programme. Graph I presents smallpox in 1969 as compared to 1967 and 1968.

SMALLPOX CASES REPORTED IN NIGERIA 1967-1969

CASES PER FOUR WEEK PERIODS



B. Outbreaks under Investigation

Smallpox is currently under investigation in Kafanchan, North Central State, and Numan, North Eastern State. The Kefanchan case was reportedly imported from Makurdi, Benue Plateau State. With the number of smallpox outbreaks decreasing, early and complete investigation of each case is manditory.

Cross notification on imported cases is essential to the achievement of eradication.

C. Areas of Concern

The achievement of eradication requires a continuing vigilance especially in high risk areas. High risk areas consists of areas which have reported smallpox in the last sixty days and unvaccinated areas and include:

Kwara State - Ilorin
North Central State - Zaria Province especially Kafanchan Area
Benue Plateau - especially Makurdi
North East - Combe - Numan Area

D. Completed Investigation

The following investigation from the Western State emphasizes interstate transmission and is an example of effective investigation and control. The initial outbreak occurred in Ilorin, Kwara State, where the wife (case 1), mother (case 2), and 3-year old daughter (case 3), of a carpenter were infected with smallpox. An apprentice and his family who were living with the infected family left Ilorin soon after the death of cases 1 and 2. Five days after arrival in Ikire in Western State, four of the family members (cases 4-7) developed smallpox. One additional family contact (case 8) and two community contacts (cases 9 and 10) developed smallpox one generation later.

Case No.	Age	Sex	Vaccination History	Vacc. Scar	Outcome	Source
4	18	M	+	+	Died	Ilorin Kwara State
5	5	M	No	No	Survived	" " "
6	3½	F	No	No	"	" " "
7	3	F	+	+	Died	" " "
8	50	M	Yes(Over 20 yrs ago)	++	Died	Household contact cases 4-7
9	45	M	No	++	Died	Lived ½ mile from cases 4-7
10	65	F	Yes(over 20 yrs ago)	++	Died	Visited compound of cases 4-7

\+ Patient died before investigation.
++ Confluent rash prevented examination for vaccination scar.

There were three uninfected residents in the compound of cases 4-8, all of whom, (19 male, 48 female, 20 male) had recent vaccination scars. Eleven of 26 compound contacts of cases 6 and 7 had no vaccination scars, but transmission did not occur probably due to early contact vaccination.

Approximately 85% of Ikire had been vaccinated in the mass campaign. Control of this outbreak was achieved by careful vaccination of household contacts and a campaign directed at unvaccinated individuals in the town. A total of 7,775 vaccinations were performed in the town with a population of 50,000.

This outbreak emphasizes the fact that smallpox is acquired through close contact. Five of the seven cases in Ikire acquired their disease from an infected compound contact. This emphasizes the importance of vaccinating every compound contact of an infected case. The mortality in this outbreak 70% is unusually high for smallpox in Nigeria and raises suspicion of unidentified cases.

E. Laboratory Investigations

With the number of outbreaks approaching zero, laboratory specimens should be obtained from every outbreak. The Federal Ministry of Health Diagnostic Laboratory has proved conclusively that some outbreaks thought to be smallpox were caused by agents from the Herpes Varicella (Chickenpox) group. Studies currently in use included agar gel diffusion, egg isolation, and electron microscopic examination from scab material. Each specimen submitted should include 10–20 scabs and a report of the case history and examination.

II. MASS CAMPAIGN

Teams are currently active in the Ilorin area of Kwara State; Adamawa and Sardauna Provinces of North East State, and the three Eastern States. Maintenance programmes are underway in Kano, Midwest, Western, and Lagos States.

THE SURVEILLANCE SYSTEM AND METHODS USED TO IMPROVE REPORTING

I. TOGO

L. Prince Agbodjan[1]

The reporting system in Togo has been significantly improved since 1967. In June 1967 notices were sent out to all health units requiring them to report cases by name and to make an epidemiological investigation of each case. These arrangements were consolidated in 1968 by various approaches made to medical officers such as circulars, memoranda, questionnaires for improving reports, and action by the Epidemiology Service.

In addition, the reporting network was extended to include groups outside the health services, including village chiefs, cantonal chiefs, school teachers and head masters, social leaders, rural leaders, rural postal officials, Peace Corps volunteers and members of the clergy.

Each person in charge of a clinic or health centre is required to report to his medical officer as soon as any smallpox cases are detected. Even doubtful or suspected cases must be reported in order that the medical officer may promptly undertake further investigation. The medical officer must report by special telegram to the national health authorities all cases reported to him, and every Monday must send a telegram giving a summary of the cases and deaths that occurred during the week before. If there were no cases during the preceding week, he must still send a telegram to indicate that there were, in fact, no cases.

INVESTIGATIONS AND RESULTS

In 1968, 784 smallpox cases were recorded, as against 332 in 1967, an increase of 136%. During this same period the world total of cases actually dropped by about 40%. Such a high figure had never been recorded before in the history of Togo; the highest figures previously recorded were 617 in 1945 and 571 in 1962. We do not think, however, that there really were more cases in Togo in 1968 than in any previous year. The reason is to be sought, rather, in the intensified scale of surveillance activities in 1968 and the consequent detection of an increased proportion of cases.

Since total vaccination of the entire population cannot be done rapidly, we adopted, in addition to the vaccination campaign, another approach - that of containment of cases so as to prevent transmission. But to contain cases one must know about them, know where they are and where they come from, and this means one has to look for them, and investigate the source of infection of all cases reported or subsequently discovered. An entirely new system of case finding and case notification had to be developed. This may be described briefly as follows.

1. I have already mentioned the measures taken to assure more complete reporting from the health units. Additionally, although the work of health unit personnel had usually been confined to the centre itself, they were now required to undertake special investigations of cases seen to determine if there were additional cases in the area and to trace their source. The clinic nurses were required to complete a special inquiry form and nominal case list and to take control measures including isolation of patients and vaccination of possible contacts.

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[1] Directeur du Service des Grandes Endemies, Togo

Final steps in the investigation were completed by the medical officers and the Epidemiology Service. Thus the investigation of six cases reported at Todome (near Anecho) resulted in the discovery of 28 other cases while an investigation that was extended to neighbouring farms in connection with an outbreak of 11 cases at Atidje led to the discovery of 13 other cases at Akepedo.

2. Since the health units' coverage of the country is not sufficiently extensive for them to detect all cases, we extended the case-finding network as I have mentioned, to include the public services and other persons outside the health services. Thus the Kanyipedji outbreak with 19 cases and eight deaths, was reported to us by a Meterology Service official and confirmed at the same time by a schoolmaster in whose school two brothers had died during the same week. An epidemic of 16 cases with four deaths in Lome district was reported by one of the citizens of the community, also the Singbohoue (Anecho) epidemic, with 34 cases, and a focus in Zsevie district by a Peace Corps volunteer; and an outbreak in Lome district by a missionary.

3. A supplementary method of surveillance was to look for signs of the presence of smallpox, in any area through which we passed. In the south of Togo it is a superstitious practice to place a palm branch on two sticks driven into the ground over any path leading to a village or farm so as to bar the way against a scourge, particularly smallpox, which is raging nearby. Following this sign invariably led to the discovery of smallpox foci.

4. Starting in September, when smallpox cases were confined to the coastal area, we organized, with the help of the National Malaria Service, vaccination and case finding teams consisting of officials on bicycles whose task it was to comb the areas of high endemicity; officials of the Anecho and Zagbligbo health subdivisions did the same in their respective areas. Needless to say, case-finding activities on this scale had never been carried out in the past. This operation detected 80 of the 84 smallpox cases notified in December contrasted to only 4 cases which were reported by the health units, formerly our only information source.

In conclusion, we have found our surveillance system to be most satisfactory. Of the 784 cases recorded during 1968, 609 (78%) were uncovered by special investigations. The programme has alerted the public to the need to report cases, and has made it possible to contain rapidly foci of infection and so hasten the day for ultimate victory.

THE SURVEILLANCE SYSTEM AND METHODS USED TO IMPROVE REPORTING

II. DAHOMEY

Dr. Maximilien Yekpe

Smallpox control has entered a new phase as progress to date causes us to believe, without undue optimism, that we really are on the way towards eradication.

STATUS OF SMALLPOX IN DAHOMEY

Dahomey is one of the countries of Africa in which the incidence of smallpox before the campaign was still relatively high, despite immense efforts made by the Government since independence. The situation was better in towns, but troublesome in rural areas because of:

1) Lack of hygiene and crowded living quarters, which provide optimum conditions for uninterrupted transmission

2) The practice of variolation by some religious sects

3) The great number of temporary farm settlements which are frequently overlooked by administrative censuses and escape medical inspection.

In addition to these difficulties, there was opposition to vaccination by some ethnic groups, a shortage of executive personnel, and insufficient financial resources.

Dahomey, which has a population of about 2.5 million, is divided into 32 "health areas", each corresponding to political boundaries. It is further subdivided into sectors. Semi-mobile operations supplement those of the exclusively mobile services. The health areas and sectors are usually run by physicians but occasionally by senior nurses. There are, in addition, 174 rural clinics. These all took part in smallpox control by giving vaccinations, exercising surveillance over areas for which they are responsible, notifying cases by telegram and immediately applying the initial preventive measures before any action was taken by the mobile teams. Such was the organization in Dahomey on the eve of the great measles/smallpox campaign in Africa.

NEW ARRANGEMENTS DURING THE ERADICATION CAMPAIGN

Since the beginning of the eradication campaign, operations have been exclusively carried out by the mobile teams of the Service des Grandes Endemies. Special procedures have been established for medical districts, hospitals, out-patient medical posts and dispensaries, both official and private, and all rural and mobile units as follows:

- notification by telephone of suspected cases of smallpox is required within 24 hours after detection.

- clinical cases must be confirmed in a weekly report.

- the person in charge of a health area is required to make a post-infection vaccination test. This test consists of

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[1] Chief Medical Officer, Southern Sector, Dahomey

vaccinating any confirmed or suspected case during convalescence. The reaction five to eight days after the vaccination confirms or invalidates the clinical diagnosis.

In addition, an action team of three persons have been formed in each of the three mobile unit sectors into which the country is divided. The duty of the team is to supplement the medical district's vaccination activities and to carry out epidemiological investigations to detect the source of infection, contacts and the villages through which a case has passed and put them under surveillance. This team, which has other duties as well, is required to be ready to act immediately after notification.

In addition, a monthly news publication for health personnel was initiated. Teachers, agricultural instructors, missionaries, and peace and progress volunteers were requested to notify cases. Finally, health units were required to submit a standardized monthly report, one copy of which is sent directly to the central office and the other to the person in charge of the area to enable him to compile an overall monthly summary.

Following the systematic, vaccination programme, additional studies were conducted to determine regional morbidity rates in order to define the geographical zones where strict surveillance was necessary and to determine particularly susceptible groups and areas where immunity was low. Among other things, these surveys showed that in certain areas one-third of the population had been absent from their villages when vaccinations took place and that over half of this group of absentees consisted of children 1 to 4 years of age. The programme of surveillance and continuing vaccination was drawn up in the light of these data.

SURVEILLANCE BY HOUSE-TO-HOUSE VISITING

Apart from the surveillance exercised by mobile teams, the rural health services, teachers and agricultural workers, there are 12 health visitors in Dahomey who have been specially trained for house-to-house visiting and whose job includes the active detection of cases of smallpox in zones where the situation gives cause for anxiety and the vaccination in these areas of all children from 0 to 4 years of age and all persons not bearing vaccination scars. The health visitors travel by motor bicycle and carry with them the freeze-dried vaccine and bifurcated needles. They wear a small apron around their waist with compartments for sterilized needles, for used needles and for vaccine. When vaccination has been performed, the used needle is placed into one of four compartments representing 1) primary vaccinees - 0 to 4 years of age, 2) revaccinees - 0 to 4 years of age, 3) primary vaccinees - 5 years of age and over, 4) revaccinees - 5 years of age and over. Vaccinations performed during a day by age and vaccination status can be easily determined by counting the needles in each pocket.

Visits are made early in the morning when everybody is in the village. The afternoon is utilized for publicity and health education in the villages to be vaccinated on the following day. Priority in visiting is assigned to areas which are inaccessible during the rains. An evaluation team determines the level of immunity before and after visits to the villages. The evaluation team also controls vaccination techniques and supervises the punctuality of personnel.

Vaccinations and surveys under this programme were carried out from 11 March to 26 April 1969 in one of the areas where endemic smallpox has always been a matter of concern. During this period, 23 villages were visited and 22,356 persons were vaccinated, including 4,351 primary vaccinees. No cases of smallpox were detected.

This pilot programme confirmed the importance of the approach in troublesome areas. The bifurcated needles were found to be especially useful. It was found that about

70 vaccinations could be performed daily by each vaccinator at a cost of 92 CFA per vaccination.

CONCLUSION

It is clear that the continual evaluation and improvement of operational methods, the organization of surprise visits, the strict application of measures decided on, and the active and systematic search for cases and for unvaccinated persons are the only roads to final victory over smallpox and measles.

The strengthening and improvement of our system of surveillance and case-finding led initially to the recording of an alarming number of cases, which was erroneously considered to be a recrudescence of smallpox, in Dahomey. However, as against 802 cases in 1967, there were only 431 cases in 1968 and three cases during the first quarter of 1969.

The unique experiment described, combining active case detection and selective vaccination, was carried out in one of the largest smallpox foci in Dahomey. Not a single case has been notified there for more than four months.

It is still too soon to speak of success but for us, knowing of the difficulties of access in this area, the problems of variolation and the hostility of the population, it is an unprecedented victory, all credit for which must be given to the organizers of the campaign and to the representatives of the National Communicable Disease Centre serving in Dahomey.

THE SURVEILLANCE SYSTEM AND METHODS USED TO IMPROVE REPORTING

III. NIGER

Issoufi Alzouma[1]

INTRODUCTION

Long before the Republic of Niger became independent, ever since the concept of surveillance was introduced into the territories of French-speaking West Africa, Niger has always notified, in accordance with the procedures of WHO, all cases of disease subject to compulsory notification. These notifications are made by telegramme, not only to Geneva, Paris and Dakar, but also to all neighbouring countries. However, it must be frankly admitted that, as a consequence of the size of Niger and the weakness of its public health infrastructure, these notifications have not always been made in good time.

After the Republic of Niger became independent, the administration was completely reorganized. In order to prevent epidemics, the principle was laid down that, from the smallest village up to the canton, every case of certain diseases of an epidemic character, such as meningococcal cerebrospinal meningitis (which is particularly lethal in Niger), measles and smallpox must be notified within 24 hours. In spite of dispensaries and medical centres, smallpox remained endemic throughout the territory of Niger for ten years until a new system of surveillance was introduced, thanks to the establishment of a special bureau for the Campaign against Smallpox and Measles.

TRENDS IN SMALLPOX INCIDENCE

Smallpox has always been a serious public health problem in Niger. Between 1956 and 1968, 12,301 cases were reported, an average of 1,028 cases per year (Table 1). The number of reported cases of smallpox declined from 1,187 in 1967 to 679 cases in 1968(Table 2). Only seven cases of the disease have been reported in the first two months of 1969, as compared with 233 in 1968 and 464 in 1967 during this same period. These figures speak for themselves.

In 1967, 1,610,473 vaccinations were carried out, as compared with the target of 1,500,000, and in 1968, 1,166,292 vaccinations, as compared with the target of 1,000,000. Thus 79.80% of the population of Niger has been vaccinated against smallpox during the first two years of the programme. The campaign is being continued in 1969, and 205,786 vaccinations have already been carried out during the first two months.

EPIDEMIOLOGIC INVESTIGATIONS

Whenever a case of smallpox, or a focus of the disease, is reported, an epidemiological investigation is immediately undertaken by a team which travels as soon as possible to the place concerned. The information obtained by means of such investigations has enabled us, not only to bring the existing foci rapidly under control, but also to prevent the appearance of new cases.

In 1968, investigations were carried out at Tera, Ouallam, Filingué, Birni-Konni, Bouza, Tessaoua and Gouré.

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[1]Director, Smallpox-Measles Programme, Niger

The effectiveness of epidemiological investigations was illustrated recently in the elimination of previously unrecognized endemic focus in the village of Kokaram (200 km north of Zinder). On 22 February 1969, a case of smallpox was reported to us from the village of Garin Kafata, 250 km south of Kokaram, near Dungass. The case was that of a 33 year old man who became ill five days after having returned from his native village. The population of both the villages of Kafata and Kokaram were immediately vaccinated.

Improved methods have been studied constantly and put into practice, since we have not been satisfied with staying in the office. Instead of simply sending vaccine to the medical officers in charge of the medical centres when they notify cases, we have visited the places concerned to check the diagnoses. An epidemiological investigation has been carried out in respect of each case of smallpox notified; the population of the village or group concerned has been vaccinated, and a mobile team sent immediately to vaccinate the population of the region in order to prevent the disease from spreading. Neighbouring countries have been warned so as to enable them to take the necessary precautions on their frontiers, i.e., to carry out vaccination in the frontier zones.

NOTIFICATION SYSTEM

Instead of a week being allowed to elapse before cases of smallpox are notified from the medical centres, we have asked every medical officer in charge of a medical centre to notify cases of the quarantinable diseases, in particular smallpox, within 12 hours after notification has been received from the villages. Since the beginning of the campaign, the most rapid means of communication have been used: telephone, telegraph, police force, army. We can say very proudly that thanks to these methods, smallpox in the Republic of Niger will soon be eradicated. A system for maintaining the level of immunity, however, must be established.

Table 1 Cases, Deaths, Vaccinations in Niger 1956-1968

	Cases	Deaths	Vaccinations
1956	665	40	426 211
1957	797	61	606 676
1958	508	48	687 076
1959	1 149	109	907 401
1960	2 408	137	1 001 715
1961	1 740	91	122 088
1962	1 083	74	321 060
1963	445	27	535 990
1964	30	4	586 703
1965	463	51	317 740
1966	1 147	37	300 501
1967	1 187	45	1 610 473
1968	679	52	1 166 292

Table 2 Cases, Deaths, Vaccinations in Niger 1968, by Month

	Cases	Deaths	Vaccinations
January	168	9	87 153
February	65	0	159 639
March	58	2	124 959
April	212	30	148 937
May	69	6	139 493
June	83	1	64 249
July	10	1	21 412
August	0	0	102 094
September	0	0	27 725
October	4	0	19 395
November	1	0	155 775
December	9	3	155 561
Total	679	52	1 166 292

SURVEILLANCE TECHNIQUES FOR DETECTING IMPORTATIONS OF SMALLPOX

F. C. Grant [1]

INTRODUCTION

The traditional method for preventing the importation of smallpox is the creation of check-points at the ports and customs stations along the territorial borders where vaccination certificates are inspected and where vaccination is done when required. In addition, suspected smallpox cases may be detected and quarantined and contacts may be placed under surveillance. However, in a region where members of the same tribe and sometimes members of the same "extended" family live on both sides of the territorial borders, there is constant movement across the borders along uncharted paths. Under such circumstances the traditional method of preventing the importation of diseases is ineffective, and greater reliance is placed on the improvement of surveillance throughout the country and the institution of prompt containment measures when imported smallpox is discovered.

It is a common observation that public interest in disease control measures, especially those which entail interference with people, begins to wane as the incidence of the disease falls and its public health importance diminishes. As has been stressed, surveillance is important as a factor in smallpox eradication and as a means of maintaining the achievements of eradication.

THE METHOD OF SURVEILLANCE ALONG TERRITORIAL BORDERS

The Republic of Ghana has a rectangular shape. It is bordered by Ivory Coast, Togo, Upper Volta, and the Atlantic Ocean. Since it is impossible to maintain effective watch - along all borders, it is useful to be able to shift efforts to where they are most needed. Knowledge of the epidemiological situation in the neighbouring countries serves as the basis for the selective deployment of surveillance personnel. There are three main sources of information. These are: (a) the radio reports from WHO Geneva, (b) the Weekly Epidemiological Record of WHO, and (c) direct reports from the neighbouring countries. In addition, newspapers serve as important sources of information about outbreaks of disease. For example in July 1968, a report of four deaths caused by chickenpox was observed in one of the national newspapers. The report was promptly investigated and 16 cases of smallpox were discovered. The outbreak was in one family of a Togolese farmer, his two wives and 14 children. They had all visited Togo to celebrate an annual festival and to observe religious rites when the vaccination teams vaccinated the district where they had lived in Ghana. One of the wives and three children developed smallpox and died within ten days following the return of the family to their farm in Ghana. The other wife and the 11 other children all developed smallpox but survived. The farmer who was the only member of the family who had been previously vaccinated did not develop smallpox.

It is part of the routine of health inspectors whose districts lie on the borders that they pay regular visits to the villages and towns within 10 miles of the borders to enquire from the traditional chiefs, teachers, pastors, and other community leaders about the presence of smallpox in their vicinity. In addition, mobile teams from the Medical Field Units are dispatched to scout for smallpox cases along the adjacent territory on the Ghana side whenever information is received about the occurrence of smallpox in a neighbouring territory.

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[1]Senior Medical Officer, Ministry of Health, Accra, Ghana

During the past 18 months no cases of smallpox have been reported in Ivory Coast. The outbreaks of smallpox in Upper Volta have been along its borders with Mali, Niger and Togo, quite remote from the border with Ghana. During this period Togo has reported numerous outbreaks of smallpox. Because Togo is a narrow strip of territory along the entire eastern side of Ghana, no part of Togo is remote from the Ghana border.

During 1968, six outbreaks of smallpox (all traced to external sources), involving 24 persons were reported in Ghana. Four outbreaks, which resulted in 22 cases and five deaths, occurred at distances in excess of 100 miles from the Ghana-Togo border; while two occurred near the border with Togo. This experience underscores the importance of increasing the sensitivity of surveillance methods throughout Ghana.

METHODS OF SURVEILLANCE EMPLOYED IN GHANA

The conditions needed for effective surveillance are a network of health units manned by trained personnel oriented to investigate and report all cases of smallpox, strategically placed laboratory diagnostic facilities, and good communications systems.

Although there exists a programme for the development of the necessary infrastructure for surveillance, this is only in the embryonic stage. At present, however, there exists a reasonable distribution of auxiliary health staff. The country is divided into nine regions and each region is divided into five health areas. Each health area is divided into four or five health post areas, according to the size and population density. The health posts are intended to make it unnecessary for anyone to travel more than seven miles for medical assistance. This means that about 220 health posts are needed. Nine of these are at present in operation.

Each health area has a health centre, and in some health areas there may be one or two hospitals in addition. Each region has a regional hospital. Three regional hospitals which are strategically placed have been designated as central hospitals. The central hospitals are intended to be developed to provide all modern medical facilities. The laboratories at the central hospitals are being developed to provide diagnostic support for both clinical and epidemiological investigations. The health laboratories are to be known as sentinel laboratories.

The network of all-weather roads in Ghana is reasonably good. In addition there are strategically placed police shortwave radio stations that can be used by the health staff.

MORTALITY REGISTRATION

Until 1968 there were 45 compulsory registration districts where it is impossible to bury a dead body without registration. These districts covered 50% of the total population. The registration areas have been further extended since 1968.

MORBIDITY REPORTING

Over a period of many years the public has learned to report suspicious exanthematous conditions. The chain of reporting is from individuals, family heads, chiefs, teachers and pastors, as well as administrative officers, to the health inspector. The health inspector is obliged to carry out his investigations and initiate control measures immediately. He reports to the medical officer of the district, who, in turn, reports simultaneously to the Regional Medical Officer of Health and to the Ministry of Health headquarters in Accra.

LABORATORY INVESTIGATIONS

Since January 1968 it has been the policy to obtain laboratory confirmation of every outbreak. For this purpose specimen collection kits have been made. The tests performed have been agar gel diffusion and haemoagglutination inhibition tests. Whenever possible, though this is infrequent, virus isolation bas been attempted. A specimen is also sent to the National Communicable Disease Center, Atlanta, USA for confirmation.

DISSEMINATION OF INFORMATION

Besides the telegraphic report of an outbreak, a weekly report is necessary which must be made even when no cases are seen. Monthly reports summing up the experience of each month are also mandatory. These reports, upon confirmation, are communicated to WHO and tbe neighbouring countries. Information obtained about the situation in bordering countries is distributed from the Headquarters to the Regional Medical Officer of Health and through him to the peripheral health units.

DEMOGRAPHIC AND SOCIO-ECONOMIC DATA

The collection of information on socio-economic status of a case helps in tracing other cases. The tribal origin helps in determining whether the case is imported or indigenous.

SPECIAL SURVEYS

While investigating reported outbreaks, the opportunity is taken to check on the take rates of vaccinations done by the health inspector and his staff. The storage condition of the vaccine is noted and a sample of the vaccine is sent for potency tests. In addition, scar rates in the area are estimated when possible.

CONCLUSION

Knowledge of the epidemiological situation in neighbouring countries determines where surveillance efforts should be intensified near the borders to avoid re-introduction of imported smallpox. In addition, the experience in Ghana has shown that it is equally important that surveillance in other areas should be sensitive for the early detection of cases. All methods of surveillance applicable to smallpox are employed. Prompt disease control measures stop the spread of the disease.

ASSESSMENT OF SURVEILLANCE SYSTEMS IN WEST AFRICA

R. H. Henderson [1]

INTRODUCTION

We have evaluated several surveillance systems during the past year in conjunction with the Phase I (attack phase) assessments in Dahomey, Gabon, Northern Nigeria, Niger and Togo. While we used several different evaluation techniques, we found that much of our most useful information was obtained from a simple review of the existing system as outlined below.

Special terms are employed in this paper to characterize three levels of the surveillance system. The "central receiving unit", at the highest level; is the unit to which all others send their reports and is often represented by the statistical unit of the Ministry of Health. The centres which report to the central receiving unit have been called "reporting centers". Most countries have 30 to 50 such centers, all of which are usually required to submit weekly telegraphic and monthly written reports to the central reporting unit. Reporting "sub-sites" are also referred to. These are medical facilities, such as dispensaries, which are supervised by the person in charge of the "reporting center." Although these sub-sites are expected to send word to the centre if a disease such as smallpox is detected, in many countries they do not submit routine reports to the centre.

METHODS

A complete and accurate description of the existing surveillance system is requisite for carrying out an evaluation. We sought, to determine which were the designated reporting centres, what diseases they were required to report, and how they were to report them. We also inquired how the designated centre obtained information from the sub-sites which were responsible to it, and asked what was done once the information had been received (or had not been received) at the country's central receiving unit.

We then reviewed the surveillance records which were available at the country's central receiving unit as one indication of how closely the system conformed in practice to the description provided. This type of review does not usually require more than half a day or a day to complete. A list of all reporting centres is made, and for each reporting period the centre is either marked as having reported or not. We have generally done this for a two year period. With these basic data, calculations can be made as to what percentage of expected reports are being received. In certain countries, all centres eventually report, but many are weeks to months late in doing so. For this reason it is helpful to make an arbitrary definition of what constitutes a late report and to classify each report as to whether or not it was on time. This can be done in conjunction with the analysis of the number of reports received from each centre.

Thirdly, we inspected as many of the reporting centres and sub-sites as time permitted. At each, we talked with the person in charge of submitting reports, and compared his description of his responsibilities with the description we had obtained at the central receiving unit. We asked to see the records of reports which the centre had submitted to the central unit as well as the records of reports which had been received by the centre itself from its sub-sites.

[1] Deputy Chief, NCDC/USAID Regional Office, Lagos, Nigeria

While the methods just described allow one to evaluate a country's surveillance system from the point of view of the appropriateness of the theoretical system to the country's needs and resources and to evaluate how closely the actual system corresponds to the theoretical system, they do not offer a means of quantitating what proportion of the actual cases of a given disease are being detected. For certain diseases, such as measles, one anticipates that the reported cases represent only a fraction of the actual cases. For an eradication programme, such as smallpox, where it is important to know about every case, one would like to have a measure of the sensitivity of the reporting system, and one would like to be able to determine whether changes which have been introduced in the reporting system have, in fact, had the desired effect of increasing that sensitivity.

Unfortunately, the measurement of the sensitivity of a surveillance system can be difficult. For smallpox, we have used assessment sample surveys to gather information on the incidence of smallpox scars in children under five years of age. By making certain assumptions, an estimate can be made of the total number of cases of smallpox which have occurred in the country during the past five years and this estimate can be compared to the number of cases which the country has reported during this period. Similar estimates can be made of the number of cases which have occurred during the past one year, and compared to the reported cases for this year. These two sets of data can then be compared to determine whether the reporting system has functioned better or worse during the past year than it has functioned over the past five years.

This technique should be regarded as being still in its developmental stages. In the three surveys in which we have employed it, the results have suggested that certain facial scars left by diseases other than smallpox may have been mistakenly diagnosed by assessors as being smallpox. We do not yet know whether this source of error can be eliminated by more careful training, which would assure that the criterion used, (the presence on the face of five or more pock marks of at least two millimetres in diameter), was rigidly adhered to, or whether a certain degree of error is inherent in the technique. In support of the latter possibility, it seems likely that certain diseases, such as chickenpox and acne, could occasionally cause facial scarring which would meet the criteria mentioned above. This is not a problem for countries experiencing a high incidence of smallpox in the under five year age group, since the number of errors in diagnosis would be small in relation to the number of cases of smallpox in which a correct diagnosis was made. As the incidence of smallpox scars decreases, however, such errors may cause a marked distortion of the results. If such errors are indeed inherent in this technique, its applicability in West Africa may be limited.

Let me hasten to add, however, that I believe we should continue to use the method in future terminal assessments, although as much to evaluate the method as to evaluate the surveillance system, and I believe that the criterion we have used for smallpox scars is a good one. In particular, countries which have reported no cases of smallpox ought to look for smallpox scars whenever surveys are done. When persons who were born since the country has considered itself to be smallpox-free are found with suspect facial scars of smallpox, an investigation should be conducted to determine when and where the person fell ill and whether a trail can be followed which would lead to the discovery of fresh cases. With all of West Africa on the verge of being smallpox-free, the diagnosis of smallpox scars in any resident born after May 1969, should be an obvious cause for concern.

RESULTS

In all of the countries evaluated in which smallpox had been recently endemic, there was evidence to suggest that the disease either had been or was at that time being under-reported. In two countries the assessment teams found cases of active smallpox among the villages which had, by chance, fallen into their sample survey. These cases

had not been detected by the country's surveillance system. In three other countries, the smallpox scar rates in children under five years of age suggested that cases which had been reported by these countries represented less than 30% of the cases which had actually occurred in the past five years.

There are several causes for not reporting cases of smallpox and many are not easily remedied in a short period of time. Discussions with health personnel who were responsible in various countries for sending reports from the reporting centres to the central receiving unit suggested that reporting of all diseases might be improved if these personnel could be made aware of the importance of this aspect of their work. While the knowledge that someone is checking their reports is one stimulus, it would seem possible and desirable to devise health education materials which would emphasize the critical role that the reporting personnel play in the functioning of the surveillance system and which would point out the critical role that the system itself plays in the functioning of the country's preventive medical services.

The major lapse in reporting exists between the sub-site, which is often staffed by personnel with limited education, and the reporting centre, and not between the reporting centre and the central receiving unit. Records reviewed at the central unit showed that the individual reporting centres were, by and large, submitting reports on a regular basis while we were rarely able to find records at the reporting centres which indicated that they received reports from their sub-sites. None of the reporting centres had a formal system for monitoring the receipt of reports from their sub-sites.

Our feeling was that the key man in the system was the man at the reporting centre level. In general, personnel at this level seemed to have enough motivation and education to be responsive to efforts to improve reporting practices, and usually seemed to be in a position of sufficient authority to stimulate better reporting from the village and sub-site levels.

Most of the central receiving units did not monitor the receipt of their reports closely. The usual system was to file incoming reports from all the reporting centres chronologically in a single folder. One unit, however, had designated a separate folder for each reporting centre. At the close of the reporting period, they reviewed these folders and extracted those lacking current reports for follow-up action. This was the only unit visited where vigorous follow-up action was being taken.

The information transmitted by the surveillance systems in the countries visited appeared to be adequate to meet their needs with regard to smallpox, but inadequate with regard to measles. Because all smallpox cases are to be investigated, the details of age, sex, vaccination status, etc., can be supplied on a special investigation form; the telegraphic report fulfills its function by giving the location and number of cases detected.

Prior to the institution of measles vaccination programmes, information concerning the location and number of measles cases fulfilled most needs and telegraphic reporting was not usually indicated. Since the advent of measles vaccination programmes, however, the situation has changed and measles reporting should also be changed.

Measles should be one of the diseases included in the weekly telegraphic reporting system. Most countries will be able to achieve measles control in urban and densely populated rural zones where yearly vaccination campaigns can be carried out, but most countries will also have certain rural zones where vaccination teams can only return every two or three years. In these latter zones, measles epidemics can be expected. With a weekly telegraphic reporting system, such epidemics can be identified at their onset and vaccination may be sent to prevent further spread.

In the rural areas, if a rigid vaccination schedule is maintained with no regard to the occurrence of measles, the teams may frequently find themselves vaccinating areas just after they have experienced an epidemic. In this situation, the team is accomplishing little. Having already had its measles epidemic, the community in question is safe until another pool of susceptible children has built up, and the team will be wasting a large proportion of its measles vaccine by giving it to children who have already had the disease. The team would be far more effective if it postponed the vaccination of that particular community, and turned its attention to areas which have had no recent measles outbreak or to those in which measles was just beginning.

Measles cases should also be reported by age and by vaccination status. This information is too detailed to be included in the weekly telegraphic reports for which the location and number of cases is the only immediately required information but it should be furnished monthly by the reporting centres. Forms have been devised which make the collection and transmission of this data an easy matter. Such information is highly relevant to the execution of effective vaccination programmes. The age indicates whether or not the majority of the cases were in the target group for vaccination during the last measles campaign. If most were less than six months of age at this time, this indicates that the pool of susceptible children has grown large enough to support an outbreak and that vaccination cycles, planned for that community, should in the future be shorter than the time which had elapsed between the last campaign and the onset of the first outbreaks. However, if most of the cases were six months of age or older at the time of the campaign, two possibilities exists: either these children were missed by the programme, indicating that future campaigns would require better organization, or they were vaccinated by the teams but remained susceptible to measles following vaccination. In the latter instance, refrigeration or vaccination techniques might have been faulty. By knowing whether most of the cases did or did not have a history of measles vaccination, one can distinguish between these two alternatives, and take appropriate action.

SUMMARY

1. Several surveillance systems have been evaluated during the past year in conjunction with Phase 1 assessments. The most useful information has been obtained by determining how the the particular system being evaluated was supposed to function in theory and then comparing that description with a study of the system as it actually functioned. This has been done by reviewing the records available at the central receiving unit and by conducting interviews and examining records at the reporting centres and sub-sites. Estimates of the sensitivity of the surveillance systems in detecting smallpox cases were made by the method used requires further evaluation before it can be recommended.

2. These evaluations indicated that, in countries recently endemic, smallpox was under-reported. The largest communications gap in the surveillance systems appeared to exist between the sub-site and the reporting centre. It is suggested that attention be given to methods which would make the person at the reporting centre level more aware of the importance of his job, in the hope that he can stimulate better reporting from the sub-sites responsible to him. Reporting centres should begin a formal system of monitoring the receipt of reports from their sub-sites, and the central receiving units should similarly monitor reports from the reporting centres. Although the information transmitted was adequate with regard to cases of smallpox it did not meet the countries' needs with regard to cases of measles. It is suggested that all countries use the weekly telegraphic system to report on the location and number of measles cases which have occurred, and to use a written report, which could be submitted on a monthly basis, to specify the age and vaccination status of measles cases.

SUMMARY - SURVEILLANCE

D. A. Henderson [1]

In the global eradication programme the most difficult concept to convey bas been that of surveillance - how it may be conducted, why it is important, what it can accomplish. In countries in this area of the world, the concept has been better appreciated than in most. But even here, there is room for improvement as I believe the discussions have brought out.

Most important, I sense that all have not yet fully appreciated the concept that there is no such thing as a single case of smallpox or a small outbreak which develops spontaneously without relationship to other cases or other outbreaks. Perhaps this is understandable. In most diseases, there are moderate or large numbers of subclinical infections. Infection is transmitted from one area to another, from one person to another for some period - suddenly, there are a number of clinical illnesses. How or by whom the disease was introduced is usually a mystery and frequently the best epidemiologist with the most elaborate studies cannot provide the answer. Such is the case with poliomyelitis, typhoid fever, diphtheria, and, in fact, most other infections. Such is <u>not</u> the case with smallpox. Subclinical infections play <u>no</u> role in transmission of smallpox. In this respect, smallpox is almost unique among the infectious diseases. When one case is detected, it is a certainty that this person acquired the disease from someone else with overt, clinical disease. It is vital that this person be identified and containment measures taken and that the source of infection of the previous case be investigated and so on. Whether or not this chain of transmission can be traced back to other known sources depends on the persistence, imagination and diligence of the investigator - it is quite clear, however, that in the great majority of cases, the source of infection can be traced back over many generations.

All of you appreciate fully how very incomplete the reporting of smallpox was at the beginning of the programme. Scar surveys conducted in various countries have shown that ar the inception of programmes, rarely more than 5% to 10% of cases were recorded. As the programmes have progressed, reporting has improved and at the same time, the incidence has fallen. One would like to know, as time progresses, how much improvement has been made in the completeness of reporting. Unfortunately (or fortunately) the number of cases normally decreases rapidly when an effective programme is conducted. Within a period of only a year or two, the number of cases in any large area has declined to such low levels that a scar survey which would include enough people to permit another estimate to be made would require examination of such large numbers as to be prohibitive in time and cost. However, as the discussions have brought out, there is an alternative and, I believe, satisfactory way to determine progress in reporting in the course of the programme. By comparing each month the total of cases reported to the total number finally detected after field investigation, one should observe a trend in which an even larger proportion of cases is reported through the notification network. As brought out particularly by data from Northern Nigeria, not only do the officially notified cases account for an increasingly larger proportion of the total but the average number of cases in each outbreak progressively declines. This, of course, reflects earlier notification. In most areas, however, I doubt that much more than 50% of cases can be expected to be reported through official channels. In other words, at least one additional case will be found on investigation for each case reported. When this

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[1]Chief, Smallpox Eradication Unit, WHO, Geneva

point is reached, the disease incidence should be at very low levels. The final test of efficacy of the system may then be employed. Specifically, every outbreak reported should be carefully studied in an effort to trace it back specifically to previously known cases. When all outbreaks in a country can be specifically traced in this manner, a smallpox-free status should not be more than months away.

INTER-COUNTRY COORDINATION

Intercountry Cooperation and Coordination: An Overview
G. I. Lythcott

Proposals for Intercountry Coordination
L. Tchelle

Experiences in Upper Volta with Intercountry Coordination of Containment Activities
C. D'Amanda

Benefits of Intercountry Coordination
A. Agle

INTERCOUNTRY CO-OPERATION AND CO-ORDINATION

AN OVERVIEW

G. I. Lythcott[1]

Inter-country co-operation and co-ordination has been one of the exciting concepts of this 19-country regional programme to eradicate smallpox and control measles. It has been repeatedly noted during the seminar that, without the co-operation of the nineteen involved countries, this Regional effort could never have come into being, representing, as it does,the first time that so large a number of contiguous nations have worked in concert towards a common goal. In addition, the two Regional health organizations, OCCGE and OCEAC, have been extremely helpful in coordinating activities among their member states and in co-ordinating specific activities among non-member states. The World Health Organization, through the funding of local costs, has made possible the participation of several countries which otherwise could not have taken part. While much of this co-operation and co-ordination has been on a planned, formal and official basis, much also, has occurred informally, through the good-will and developed sense of urgency and commitment among the Ministries of Health and the International and Regional Health Agencies.

During this session, we would like to discuss the methods for inter-country co-operation and co-ordination for the future to consolidate and sustain our gains, and to identify mechanisms that will ensure a continued growth and development of this programme.

Programme experiences will be presented in Niger, Togo and Upper Volta which point up the sorts of approaches which individual programmes have taken to cope with problems of intercountry cooperation and co-ordination. They are in many ways unique.

These experiences relate to the routine intercountry co-ordination of planning of vaccination programmes along common borders; planning the control of outbreaks when disease is occurring across national boundaries and, most important, the intercountry notification of disease outbreaks.

While co-operative efforst in Niger, Togo, Chana, Dahomey and Upper Volta have been accomplished with measurable success, frequently on an ad hoc and unofficial basis, permanent systems should be implemented that would protect and sustain the accomplishments to date.

One can with some certainty predict an interruption in the transmission of smallpox in West Africa before the end of the current year. One can preduct with much the same certainty that, for some period after the cessation of transmission, sporadic cases of smallpox will occur through importation which may infect a small reservoir of susceptibles. It is, therefore, mandatory that, procedures for immediate containment be maintained within a given country, and that efficient notification systems be established and maintained to protect neighbouring countries.

In this programme, two major systems for intercountry notification of disease outbreaks are employed. The first consists of the official reports of cases which are sent from a country to the WHO and the prompt return reporting by WHO, as appropriate, to countries whose borders may be challenged by a particular outbreak. The second, frequently faster system, is the ad hoc interchange of cables between and among the various advisors. Both systems have served a useful purpose in this Regional

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[1]Chief, NCDC/USAID, Regional Office, Lagos, Nigeria

programme, especially the latter during the period of "eradication escalation".

In my view, the established WHO reporting system has not worked as efficiently as it could, (especially for prompt notification), and experience suggests that the problems in the system do not devolve primarily on WHO, but on the individual country ministries and their own surveillance systems. Direct communication between technical advisers is neither official nor permanent. It represents an internal arrangement to get a job done. At some point in time, this mechanism will no longer be available.

We must, then, bolster the established and official WHO reporting system and take whatever steps are necessary to ensure prompt reporting from the geographic site at which the outbreaks occur to the Ministry, prompt transmission of this information to WHO, and rapid verification of the outbreak by appropriate local health workers. The WHO has been in the business of disease reporting and cross notification for a long time, and can take it from there to notify other appropriate Ministries of Health.

Finally, I should like to say a few words on overall intercountry co-operation and co-ordination and mechanisms for protecting the gains and insuring the future growth and development of this regional programme.

As has been pointed out, the enthusiasm and commitment of the participating countries have been responsible for the success of the programme. In and of themselves, mass vaccination programmes, properly carried out, tend to create for a time interest and enthusiasm both among the populace and among those who are responsible for the programmes.

While interest, enthusiasm and commitment to disease control may continue at the individual government level, human nature being what it is, I feel it is safe to predict that interest in regional disease oontrol after the interruption of indigenous smallpox will surely diminish. Some countries have developed new institutions for the delivery of health services;other countries have improved upon already existing institutions for disease control; all 19 countries working in concert are palpably near a goal that few could have reached alone.

The political-administrative melieu in which intercountry co-operation and co-ordination must be developed is, by its very nature, complex. The factors surrounding the sovereignty of nations, the immutable dictates of protocol and the rules governing lines and patterns of communication, all combine to frustrate a basic desire for co-operation and co-ordination.

To protect this investment in time, energy and funds, we must look to the development of a permanent system for epidemic disease control. Such might be achieved by a regional co-ordinating committee on smallpox eradication or a regional committee for communicable disease control which could develop epidemiologic and other guidelines and recommendations for smallpox and other diseases.

PROPOSALS FOR INTER-COUNTRY COORDINATION

L. Tchellé[1]

On the basis of experiences to date in the mass campaign against smallpox and measles, communicated to the President of the Republic of Niger, His Excellency Diorio Hami, we have been authorized to submit to all the interested neighbour states of Niger a plan for joint action, from both the medical and the administrative points of view, for the effective control of smallpox and measles.

The importance of coordination between countries was recognized by the OCCGE at its interministerial meeting at Niamey in December 1967. Only by close coordination would it be possible to avoid propagation of communicable diseases, and in particular of smallpox and measles, from one country to another.

Control of these diseases is necessary, in fact, not only when epidemics occur but also also under supposedly normal conditions.

1. Control during Epidemics

(a) In order to protect the population of the frontier areas and to avoid propagation of smallpox and measles, vaccination teams should be permitted to penetrate a neighbouring country up to a distance of about 50 km for the purpose of carrying out vaccinations around an infected focus and to vaccinate any groups of nomads encountered. Such action should be preceded by official notification to the administrative, political and public health authorities of the country concerned;

(b) All information collected concerning the epidemic should be communicated to the competent public health authorities of the adjoining countries, both in the case of smallpox and that of measles;

(c) The public health authorities of the neighbouring countries should be informed of the movements of groups of nomads and of their crossings of the frontiers, so that preventive measures can be taken.

2. Control during normal periods: attack and maintenance

(a) The attack phase of vaccination should consist of joint vaccination on both sides of the frontier and up to a depth of about 150 km into the interior of the countries concerned;

(b) The maintenance vaccination phase should provide for vaccinators at all entry points into neighbouring countries so that any travellers not holding vaccination cards may be vaccinated. We call for a check on vaccination cards at the frontier. This is perfectly normal, since in preventive medicine what is sauce for the goose is sauce for the gander. No distinction must be made between travellers by air, land, sea or river. Every traveller crossing the frontier must be subject to the same public health requirements, since disease does not choose any particular method of entering a country. It may perhaps prefer, like us, to travel fast, i.e. by air, or by land, sea or river if it is not in a hurry, but whatever the route, it is sure to reach its destination sooner or later. To illustrate what I mean: every traveller between Lomé and Cotonou, two large

[1] Director, National Public Health Service, Niger

cities in neighbouring countries, must produce an international vaccination certificate if he travels by air, but if he travels by land he is not subject to any public health requirements whatever;

(c) A monthly statement of the number of cases of communicable disease by geographical region, should be sent to each neighbouring country. The Government of the Republic of Niger, in fact has already sent letters to all countries adjoining Niger to ask them to cooperate in the control of smallpox and measles. This action was decided upon as a result of the difficulties encountered at the frontiers. For example, numerous cases of smallpox and measles were detected during 1967-1968 in the regions of Konni and Mainé-Soroa, on the Nigerian frontier; Menaka, on the frontier of Mali; and Botou, on the frontier of Upper Volta.

EXPERIENCES IN UPPER VOLTA WITH INTER-COUNTRY COORDINATION OF CONTAINMENT ACTIVITIES

C. D'Amanda[1]

I should like to describe recent epidemiological problems of smallpox in Upper Volta which have served as a basis for modification of the reporting mechanisms.

Upper Volta is a country of some five million people, the vast majority of whom live in villages of less than 1000 persons; there are only two urban communities which approach 100,000 people. The country shares borders with six other countries. The central position of Upper Volta, between cattle producing areas in the north and cattle markets to the south, creates unique problems as large groups, associated with the seasonal movement of livestock, traverse the country on a north-south axis, passing through time-honoured market places.

During the first year of the programme, almost all smallpox patients were found along these major trade routes. During the second year, however, the pattern changed. The more recent outbreaks, the last one now over six months ago, occurred in small isolated border villages far from effective regular health facilities. Because of this pattern, the Sante Rurale's plans for the vaccination campaigns of 1969 and subsequent years have been designed first, to protect the frontier cercles and then to move the teams to the inner or central core of cercles. This new strategy could be said to be a direct result of the investigation of the outbreaks at Gani, on the Mali border, and Botou, on the Niger border.

We first became interested in Gani in May 1968 when a telegram from Mali reported smallpox on the Mali side of the frontier, which had presumably been introduced from this village. A visit at that time revealed seven cases, all in the desquammation stage. In November 1968, one of the prospective teams again reported smallpox in this area. A visit by the Medecin-Chef of the Secteur and programme personnel revealed 40 cases among non-vaccinated individuals. Twenty-three cases were in the newborn to 4 year age group and 17 in the 4 to 14 year age group. All cases were in the late desquammation to early scarring stage. The index case had come from Kouna, in Mali, and had returned thereafter recovery.

After the necessary containment procedures were taken and the team had returned to Ouagadougou, immediate notification was made to Mali, and plans were developed for a joint visit to investigate both sides of the frontier. This investigation has been previously described. By involving staff from two country programmes, foci of smallpox on both sides of the border could be investigated and, contained responsible professional staff could discuss, at the site of a major problem, methods to avoid similar occurrences in the future.

An outbreak at Botou, a small village within 3 kms of the Niger border, was first reported by telegram to the Director of the Sante Rurale in late September 1968. Within 24 hours, programme personnel investigated and found 19 cases, all in non-vaccinated persons. Nine were in the newborn to 4 year age group, 5 in the 5 to 14 group, and 5 in the 15 to 44 year age group. One death was also reported. Again it appeared that the epidemic was in a late stage. The Niger programme was notified on the same day, and within 48 hours, Niger program staff were vaccinating villages on their side of the frontier. A second visit by Upper Volta personnel 10 days later uncovered only one more patient, a three year old girl who had died two days

[1]Medical Officer, Adviser, NCDC/USAID, Ouagadougou, Upper Volta

previously. Further vaccinations were performed among people in the village who had not been vaccinated during the first visit. The combined effort at Botou represented an effective culmination of efforts undertaken over many months by Niger and Upper Volta to develop rapid communication and response.

Gratifying as these two exercises were, in both there was a serious delay in reporting. There are evident reasons for this. Of the 44 cercles into which Upper Volta divided, 26 have a border on the frontier and 18 lie in the "interior". The "interior" area comprises one third and the frontier area two thirds of the total area of the country: While 25% of the population of the country live in the interior, 75% live on the frontier. The dispensaries of the country are so distributed that one dispensary must serve 25,700 people on the frontier, while one dispensary in the interior serves only 5,900. Thus, such villages as Gani and Botou represent those in two-thirds of the country's area, and three quarters of the country's population, but they have only one third of the country's potential reporting units. While this is the situation in Upper Volta, it is not improbable that the situation is similar in other West African countries.

A vigorous effort to strengthen this network has been made in Upper Volta. A new system was initiated in January 1969. Weekly reports are sent to the Medecin Chef in each cercle from a total of 604 static and mobile health units; including itinerant leprosy staff. The reports are summariized and forwarded to the capital. This system, now three months old has already markedly improved the information available. However, even when all units report weekly, the system will not overcome the large differences in number between frontier and interior reporting units.

Other ways to increase the strength of the frontier notification network should be considered. As the cattle raisers follow the imperatives of pasture land, water, and markets and traverse frontiers at will, it would seem requisite for effective disease control to assure a prompt exchange of information, between neighbouring countries. By doing so, contiguous frontier areas can complement each other in strengthening the network of reporting sites.

BENEFITS OF INTERCOUNTRY CO-ORDINATION

A. N. AGLE [1]

Intercountry co-ordination has been possible, necessary and practical since the beginning of this Smallpox Eradication/Measles Control Programme. It has often been stimulated and certainly facilitated by the technical advisers working in the programme. This is true in the case of Ghana, Togo and Dahomey because for most of the time since the programme began, we have shared a medical epidemiologist, whose travels have allowed him to keep abreast of the situations and needs in each of the three countries.

Three types of co-ordination in particular should be noted: (1) commodity transfer, (2) border area vaccination campaigns, (3) notification of border area epidemics.

Transfer of various commodities among the three countries has been a common occurrence. Obviously we enjoy a particular advantage in that the distances between the three capital cities are not great and supplies can be sent from one to another easily and on short notice. Had it not been possible to transfer vehicle parts from one country to another, programme activities would have been hampered and nearly interrupted at certain times in Togo. Had it not been possible to transfer vaccine from one country to another, there would have been instances when vaccination activities would have been temporarily suspended.

Successful border area vaccination campaigns have been concurrently conducted along the Dahomey-Togo border in one instance, and along the Togo-Ghana border area in another instance. Both of these campaigns were preceded by planning meetings between programme personnel from the respective countries.

The usefulness and desirability of immediate intercountry notification of smallpox cases, particularly those occurring along the borders and those found to be importations from a neighbouring state, have been discussed. It was decided that this practice should be undertaken but that it could be done most easily and quickly on an informal basis by the advisory personnel in order to avoid the delays engendered by communicating through conventional official channels.

To date, most intercountry co-ordination has been carried out unofficially. Obviously, however, an official system which was similarly rapid and efficient needs to be established.

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ASSESSMENT

Principles of Assessment
R. H. Henderson

Concurrent Assessment during the Smallpox Eradication-Measles Control Programme in Guinea, December 1967 through February 1969.
B. Alecaut, J. G. Breman, M. K. Famba.

Concurrent Assessment of the Smallpox Eradication Programme in Mid-West State, Nigeria
I. S. Mebitaghan, P. A. Okoh

Assessment in the Central African Republic
N. Ewen

Assessment of Vaccination Coverage and Smallpox in Five Areas of West Africa: A Summary of Terminal Assessment Results.
R. H. Henderson, H. Davis, D. Eddins.

Summary
J. D. Millar

PRINCIPLES OF ASSESSMENT

R. H. Henderson[1]

I. INTRODUCTION

Assessment, by definition, is an activity which involves the collection of data which objectively measure various aspects of the functioning of programmes. It is evident, however, that the activity cannot stop with data collection, but that these data must be analyzed, and, on the basis of this analysis, a decision must be made as to whether or not to change the programme. You will recognize the similarity of this concept to the concept presented of surveillance, which also involves the three elements of data collection, analysis, and action on the basis of the analysis.

During the remainder of the day, we will be referring to three forms of assessment: concurrent, "spot check," and terminal. I would like to discuss what we mean by these terms, and the role that each type of assessment is suited to play in a country's programme.

II. CONCURRENT ASSESSMENT

Assessment activities undertaken by a country to provide a continuous flow of information on the functioning of a programme, as that programme is actually being conducted, are referred to as concurrent assessment activities. Dahomey is now completing a special multiple puncture vaccination project in an area in which the inhabitants have been noted for their resistance to vaccination. The techniques which the Dahomey programme is using to assess this project provide a good example of the range of methods which can and should be employed in doing concurrent assessment.

The principal method used is a sample survey of vaccinated areas to determine coverage rates and take rates. Dahomey has modified the usual survey method in order to use a single survey to determine both what the pre-campaign vaccination scar rates were and what changes have occurred as a result of the vaccination team's coverage. This has been extremely useful, since it has clearly defined what the target population ought to be, and it has provided information on the team's success in reaching it.

Other methods are also used. Each vaccinator keeps a daily record, listing the name of each village and hamlet in which he has worked. Beside each, he records the number of vaccinations he has performed, dividing them into the age groups of 0 through 4 years and 5 years or older. Within each age group, a distinction is made between primary vaccinees and revaccinees. The team's instructions are to vaccinate all children under the age of five, and to vaccinate those over five who wish to be vaccinated or who lack a previous vaccination scar. From these data, average daily work outputs are calculated for each vaccinator, tabulating both the total number of vaccinations per day and the number of primary vaccinations per day. With this information, vaccinators who are performing at sub-standard levels can be identified and corrective action can be taken.

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[1]Deputy Chief, NCDC/USAID Regional Office, Lagos, Nigeria

Within defined geographic areas, the total number of vaccinations performed in the under 5 age group can be compared to the number of children which the census of the area suggests should exist. This provides an estimate of vaccination coverage in small sub-sections of rbe population; the sample survey more accurately defines coverage but the figures, of course, are only applicable to the entire area included in the survey.

The list of villages and hamlets which the team has vaccinated is reviewed with local authorities of the area to identify any villages which may have been missed. The programme is also following vaccine usage as a guide to the accuracy of the vaccination figures which the teams submit.

These assessments resulted in changes in the Dahomey vaccination programme. Missed villages were visited, team members were re-trained in the multiple puncture technique after low take rates were documented, and work schedules were modified to place greater emphasis on health education when it was discovered that mothers were particularly reluctant to have their newborn babies vaccinated. The work outputs of the team members were reviewed and those persons who recorded vaccinating a high proportion of re-vaccinees were redirected to the importance of vaccinating primary vaccinees.

The discussion of concurrent assessment will occupy a major proportion of our time for the remainder of the day and so I will not dwell on it further, except to say that this is by far the most important of the three types of assessment which we will be discussing.

III. "SPOT-CHECK" ASSESSMENT

"Spot-check" assessments are nothing more than the name suggests: those activities which provide a quick and usually superficial look at the manner in which programmes are functioning. They can be considered to be a subdivision of concurrent assessment since they are usually done to provide information about some ongoing aspect of the programme, but I believe it is worthwhile to categorize separately to emphasize the fact that all programmes should be carrying them out, and that the information gained. while often superficial, is often extremely useful.

While "spot-check" assessments can be performed by anyone at any level in the programme, it is perhaps the only type of assessment in which persons at the programme director level have an opportunity to participate regularly, and directors who do not take this opportunity are doing a disservice to themselves and to their programmes.

Spot-checks on the activities of the vaccination teams can be particularly rewarding. During a visit to the teams which may last for no more than an hour, one can observe whether the "cold chain" employed by the team is actually keeping the vaccine at the desired temperature and whether good vaccination technique is being used. In this regard, it is often worthwhile to check the dosage setting of the jet injectors, and to verify that the smallpox injector is producing an adequate wheal on the arm. During a short walk through the area being vaccinated, one can obtain an approximate idea of the proportion of persons covered by the team and one can determine whether or not everyone is aware that vaccinations are being given. One can also pay a visit to an area that is scheduled for vaccination on the following day to determine whether adequate advance publicity has been carried out.

One should not be dissuaded from doing spot-check assessments for fear that the data obtained will not be statistically valid: in this type of assessment, one seeks to make simple and commonsense observations, and the statistical validity of these is of secondary importance. If one suspects but cannot statistically confirm that something is amiss, one can conduct a more formal investigation to obtain sufficient data to clarify the situation. In many instances, however, a few observations are all that are necessary to indicate that corrective action should be taken. Where one or more children show no vaccination mark and yet give a history of having been vaccinated that day, vaccination techniques clearly need to be reviewed with the team. Such a situation occurred on the first day we visited the special vaccination teams in Dahomey. In visiting several villages which had been the scene of a smallpox outbreak recently, the programme operations officer and I found that there were a number of unvaccinated persons who were sharing houses with smallpox cases still in their infectious stages. In a situation such as this, one does not need to ponder about the statistical validity of the finding! On the basis of this spot-check we were able to redirect the emphasis of the outbreak control teams to prevent this situation from recurring.

IV. TERMINAL ASSESSMENT

Assessments which are carried out at the end of the systematic vaccination phase of a programme can be classified, logically enough, as being terminal assessments. In regional programmes such as ours, the team is often given a more specific meaning, referring to a more or less total evaluation of a country's programme by persons who are not members of that programme. Such evaluations have already been completed in the Gambia, Northern Nigeria, Gabon, Western Nigeria, Niger, Dahomey and Togo, and will probably be carried out in several other countries during the coming year.

Thus far, these evaluations have had two components: a review of headquarters records and inspection of various elements of the programme and a sample survey of vaccinated areas of the country to determine the coverage achieved by the programme and the vaccination scar rate which exists in the population. This latter activity is carried out by a team of several persons. Efforts have been made in all past assessments to include on the survey team personnel from the programme being evaluated as well as personnel from programmes of neighboring countries. Each assessment has had a team leader who has been responsible for analyzing the data which have been collected, and for incorporating them into a report.

These assessments have had several purposes. They have been intended to provide an evaluation, as unbiased as possible, of a country's total programme, not only to identify weak points, but also to identify those factors which have contributed most to the programme's success. The hope is that countries within the entire region of West Africa might be able to learn from the success and failures of the programme of the particular country being evaluated. These assessments have also served other purposes. We have used them to test various techniques of conducting surveys and as a means of teaching assessment methodology to the personnel who have been involved with them. Personnel from neighboring countries who have served on a survey team have often benefited from seeing how the programme is handling certain common problems, and their pooled experience has been useful, in turn, to the country being evaluated. It should be mentioned that in addition to these "internal" purposes, the terminal assessments have a very necessary "external" use: they provide information which is used by USAID in considering the nature of future support to be provided to the programme in question.

As useful as we have found the terminal assessments to be, I would like to emphasize that they are no substitute for concurrent assessments since specific deficits may be recognized too late to be of use to the programme being evaluated.

CONCURRENT ASSESSMENT DURING THE SMALLPOX ERADICATION AND MEASLES CONTROL PROGRAMME IN GUINEA - DECEMBER 1967 TO FEBRUARY 1969

B. Alecaut[1], J. G. Bremen[2], M. K. Famba[3]

I. INTRODUCTION

The directors of the Smallpox Eradication and Measles Control Programme (SMP) began planning the mass vaccination of Guinea in October and November 1967. From the start, the continual evaluation of programme progress was given the highest priority. There are several justifications for having a systematic current critique of the programme.

Guinea has reported smallpox every year for as long as such data have been collected. More than 3,000,000 smallpox vaccinations have been done since 1958. However, the epidemic of 1966-1967 was one of the most serious in history. During that period the incidence of smallpox in Guinea was one of the highest in the world. But why?

Until the mid 1960's most of the vaccine used was not freeze-dried; vaccine refrigeration was almost impossible in a country where over one third of the surface area is immediately sub-Saharan. Major reactions among primary vaccinees during that period were estimated at 20 to 30%. Therefore, even though the more stable lyophilized vaccine was being used with improved methods of vaccine conservation and application, we did not want to repeat the earlier unsuccessful effort and leave the population unprotected.

Secondly, demographic information for West African countries is understandably inexact. Guinea may have a more accurate village by village census than many nations, developing and developed, because of her excellent internal organizational hierarchy. Nevertheless population flux due to seasonal occupational migration, and growth, dependent on migration, birth and death rates led us to conclude that we needed a more current estimate of population coverage than simple comparison of vaccination tally sheet totals to the administrative census. Such a comparison does not provide age specific group coverage or a precise evaluation of vaccine potency and team technique. These determinations require the reading of major vaccination reactions among primary vaccinees.

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[2]Medical Officer, Advisor, NCDC/USAID, Conakry, Republic of Guinea.

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II. ASSESSMENT TEAM ORGANIZATION

Virtually the entire assessment of the more than 3,000,000 smallpox vaccinations given in Guinea since December 1967 has been done by one team. The team leader, Mr. Kourouma Famba, is an Agent Technique de la Sante and was a Chef du Secteur of the Service National des Grandes Endemies, before he joined the SMP as Assistant Programme Director for Assessment. Mr. Kourouma has had more than twenty five years of public health experience in the West African bush and is fluent in the three major national languages.

During the ten day comprehensive training period before the mass campaign began, all personnel received an orientation on assessment as part of their course. The Chief Assessor studied assessment principles and methodology in greater detail and, in fact, presented this section of the course during the refresher meetings which preceded the second phase of vaccination activities. He was assigned a chauffeur and Land Rover. For more than a year the assessment ream has had only these two permanent workers. Recently a nurse has been added.

At first it was suggested that the assessment team leader could train regional health personnel to perform the evaluation independently in their own regions. This approach proved unworkable because: 1) regional authorities had other primary responsibilities; 2) there was concern that local officials would be biased, and favour giving their domains higher coverage than actually obtained; 3) transportation at the regional level was unreliable; and 4) accuracy in reading major reactions would be decreased because of the lack of experience. Each of these limitations was observed in one such evaluation performed by regional workers. Regional health personnel have nevertheless, worked with the SMP assessors, serving capably as sources of information, coordinators, guides, interpreters, and recorders.

Therefore, early in the programme the assessment became an independent, relatively autonomous activity, responsible only to the programme directors in Conakry.

III. THE ASSESSMENT

There are twenty-nine administrative-medical regions in Guinea. The region serves as the individual vaccination and assessment unit because it is a geographic, administrative, political and medical entity. Each region is further divided into arroodissements, and these are composed of committees or villages, which are the smallest organizational units.

During the first year of field operations, the assessor chose thirty villages for assessment in each region. The villages and number of persons examined in each village was dependent on village size as listed in the most current administrative census (1967). All cities with more than 5,000 were individually assessed.

Since October 1968 the number of sampling units within a region has been dependent upon the estimated regional vaccination coverage. When the estimated coverage is poor, more sites are chosen. A cluster of 33 persons are visited at each site. Cities with more than 5,000 persons are evaluated separately in the same way as during the first phase. As many major market centres as possible are also visited.

Initially, the acceptable regional vaccination coverage was set at 80% of the general population. The finding of 97% major reactions among primary vaccinees was established as the acceptable level for vaccination takes. As the programme progressed the goals were refined and percentages raised. At present we attempt to vaccinate 90% of persons in all age groups and to obtain 98% major reactions in primary vaccinees.

IV. RESULTS

For ease in appreciating programme progress, assessment results have been divided into the two vaccinating seasons. The first phase began in December 1967 and continued to June 1968. Following the rains, the second phase began in October 1968 and is continuing. The findings are divided into seasons because programme operations were quite different during each phase. Throughout the first phase, all teams would work in an arrondissement for only one or two days. Traditional collecting points were used extensively as vaccination centres. During the second phase we have tried to send teams to as many villages as possible, extending their stay in the arrondissement.

A. The Systematic Assessment

Consideration of a few selected regions is worthwhile to indicate what changes if any were implemented when initial objectives were not achieved.

Forecariah was the pilot project vaccination zone. Despite intense publicity generated from the regional capital, initial coverage was below 80% by tally sheet figures and by systematic assessment. At that time three things were done.

1. An advance information team was created, responsible to the SMP Director, but which worked harmoniously with regional officials ahead of the teams.

2. A permanent follow-up team (equipe de secours) was established to work in areas identified by tally sheet or by assessment to be less than optimally covered.

3. An Assistant Director for Field Operations was created who would coordinate team vaccination activities. This allowed programme directors more time to publicize the programme well ahead of the teams.

At Kindia, the second campaign focus, major reactions were found to be 94%, an unacceptably low value. At that time a medical officer from the SMP performed two market surveys and found major reaction rates of 99%. Nevertheless, vaccine conservation and team technique were carefully scrutinized.

Because of technical difficulties, regional authorities did their own assessment in Dabola. Tally sheet comparison showed 66% regional vaccination coverage. Assessment by Regional personnel showed an 86% coverage and 94% major reactions. A review of the Dabola assessment showed that several procedural errors had been made. Subsequently, the Chief Assessor remained in each region throughout the evaluation.

Before considering other specific immediate programme changes which were made following a regional assessment, let us look at the sum of information gathered (Table 1).

TABLE 1

Summary of Assessment Results

Age	First Vaccinating Season (Dec. 67-June 68) Number Examined	% Vaccinated	Second Vaccinating Season (Oct. 68-Mar.69) Number Examined	% Vaccinated	Total (Dec. 67-March 69) Number Examined	% Vaccinated
0-4	19,551	88	4,913	89	24,464	88
5-14	28,772	88	7,169	91	35,941	89
15-44	41,738	86	10,066	87	51,804	86
45 +	11,140	78	2,548	85	13,688	79
TOTAL	101,201	86	24,696	88	125,897	86

In examining each age group during the first vaccinating season, we observed that persons 45 years and older had the poorest coverage. We noticed this in region after region throughout the first year and were convinced that this was because of the inability of the aged to walk long distances to collecting points. Some attempts were made to send teams out to as many villages as possible. Major limitations in reaching each village included the poor state of the vehicles, centralized vaccine conservation, difficult terrain and time.

In preparing for the second vaccinating season, two major alterations were made:

1. Each team was assigned to at least one arrondissement for the duration of the campaign. Their stay in the arrondissement was usually about 10 days but varied from one to three weeks.

2. Each team was to visit every accessible village in the region regardless of size or distance.

To implement these modifications the appropriate support was arranged.

The age group coverage for persons over 45 years is now 85% compared to 78% for the first phase. Coverage in younger persons has also increased, but the major success has been in reaching persons who, we have found, will not walk more than two to three kilometres to be vaccinated.

B. Tally Sheet Comparison

More than passing reference must be made to assessment using only tally sheet coverage. As stated earlier, administrative censuses in Guinea have proved extremely reliable. These data are used in several ways.

The vaccinating team recorder and team leader tally the number of villagers presenting for immunizations. The team leader informs the village or committee president how many people appeared. If the percentage is low, the

president may send for the rest of his village; he may make arrangements for the team to return to the village; or he may send the late comers to another nearby village which has not yet been vaccinated.

When teams finish their regional work they present the Assistant Director with a village by village census and tally of vaccinations performed at each village. This list is shown to regional medical and governmental officials. It serves as the basis for estimating the number of sites for the assessors to visit. It is also the initial guide for follow-up team activities. The Assistant Programme Director uses this information in leaving supplies of dried vaccine for regionally performed vaccination activities. The number of doses for vaccino-style application is dependent on local refrigeration, expected follow-up team assistance, smallpox endemicity or threat, and the number of travelers passing through the region.

A comparison of regional coverage by tally sheet-census data and systematic assessment is shown in Table 2. One is impressed that during the first year of activity the tally sheet generally showed a much lower regional coverage than was found during assessment. In many of the regions the assessor did not visit an adequate distribution of sampling sites to make his findings completely reliable.

TABLE 2

A Comparison of Vaccination Coverage
Estimated From Vaccination Tally Results
and From Assessment Surveys

	First Vaccinating Season (Dec. 67 - June 68)	Second Vaccinating Season (Oct. 68 - March 69)
1) Vaccination Tally Results/1967 Census	77%	88%
2) Assessment Survey Results	86%	88%

V. SUMMARY OF ACTION TAKEN BECAUSE OF POOR COVERAGE OR UNACCEPTABLE TAKE RATES

It was found worthwhile to intersperse assessments with immediate and subsequent action. This was done because it was felt that when the findings were summarized and interpreted quickly, the appropriate response could be made immediately.

The considerations which affect follow up actions are the following:

A. The overall and age specific coverage within the vaccinated unit. (Regions are often broken down into smaller geographic-population components for the follow-up effort).

B. The percent of major reactions within the population assessed.

C. The smallpox threat to the region.

D. The availability of local resources to continue vaccinating by vaccino-style and assurance of proper vaccine conservation.

E. The availability of SMP personnel and resources to assist regional authorities.

Approaches to poor coverage are standardized in the Guinean programme.

A. Reasons are sought to determine why there was poor coverage (i.e. poor advance publicity, closed routes, vehicle malfunction, limited gas or oil supplies, vaccination done on holidays, etc.) and attempts to resolve the specific causative operational factors are immediately made.

B. A regional follow up vaccination programme is established and a supply of lyophilized vaccine is left.

C. A follow up team(s) is sent to the region.

D. In areas where take rates have been below 97%:

1. The SMP Medical Officer has visited the region to verify this finding and to evaluate the level of immunity to smallpox. In no instance has he found major reactions below 98% in primary vaccinees.

2. Vaccine conservation and team technique is scrutinized in the field by the Programme Director, Assistant Directors, and technical advisors. All team members are constantly urged to reevaluate their own methods of vaccine conservation and vaccination technique.

3. It has not yet been necessary to discard any particular supply of smallpox vaccine or to submit any samples for titration although some measles vaccine has been submitted for potency testing and subsequently discarded.

VI. MAJOR ASSESSMENT PROBLEMS

Our systematic assessment is often begun more than two weeks after the vaccinating teams have left, precluding the possibility of reading major reactions.

Under these circumstances, evidence of a fresh vaccination scar (which can usually be identified for at least a month in primary vaccinees), can be used.

VII. SUGGESTIONS

A. Stratification of villages into groups greater and less than 500 persons has been contemplated. Close to 90% of smallpox cases in Guinea over the past two years have been found in villages of less than 500 persons. It seems reasonable, therefore, to make a biased effort to determine how well the populations of small villages are protected. Presently, the larger the village size, the greater chance it has of being chosen as one or more sampling sites by the assessors.

B. It would be quite easy for assessors to do smallpox pock mark surveys. This information can be used to evaluate the surveillance system and to identify areas where surveillance techniques need reevaluating.

C. Assessors can be used to perform not only smallpox immunity surveys but can contribute to evaluation of many other diseases. Any disease survey depends upon many of the same skills utilized by SMP assessors.

VIII. SUMMARY

In closing, I would like to quote from a World Health Organization smallpox unit publication.

"The total absence of reported cases in the context of an effective surveillance system represents, of course, the ultimate assessment of the programme. Measurements of vaccination coverage provide interim information on the progress of the programme."

The assessment in Guinea has had philosophical and scientific justification and priority despite the realization that one can vaccinate without assessors. It has been the purpose of this presentation to show that an assessment, be it tally or systematic, can reflect exactly how well the programme has achieved its stated objectives. Areas of improvement can therefore be easily and promptly delineated.

CONCURRENT ASSESSMENT OF THE SMALLPOX ERADICATION PROGRAMME IN MID-WEST STATE, NIGERIA

I. S. Mebitaghan[1]

P. A. Okoh[2]

I. INTRODUCTION

The Mid-West State of Nigeria, with its capital, Benin City, extends over an area of 15,000 square miles and has a population of 2.5 million people, mostly farmers. It consists of 14 administrative Divisions, and, because of its multiple languages, it is sometimes described as a "mini Nigeria."

The state was invaded by the rebels from the East Central State in August 1967 and, although they have long been driven from the Mid-West, there are still attempts at sporadic infiltration, especially at the eastern boundary.

The Smallpox Eradication and Measles Control Programme (SMP) was launched in July, 1967. Although it has been functioning since, the Civil War, which was experienced more in the Mid-West than in most other states, has slowed down the project. The project started with three teams and a fourth was later added.

The role of the assessment team in the programme in the Mid-West is to evaluate by random sampling the percentage of coverage and the vaccination 'take' rate. The team provides, in a sense, an audit of the programme. For example, areas of poor coverage (below 80%) revealed by the assessment team are identified and revisited by a follow-up team. Where the take rates are below 90% something must be done to check the potency of the vaccine or to improve on field vaccination techniques.

II. THE ASSESSMENT TEAM AND HOW IT WAS DEVELOPED

The selection of an assessment team depends on the availability of suitable personnel. An assessment team may consist of two or more persons or of just one man. The Mid-West has tried both methods. During the pilot project of the SMP, there was a reserve of personnel and the assessment team was staffed by trainee Medical Field Unit Assistants with Class IV Secondary School Certificates. The team of four with an appointed leader was independent of the vaccination team and a motor vehicle was allocated to it. The team was first required to assess the pilot project area over a one month period. Morale was high at the onset, but by degrees, individual enthusiasm began to decline, and they came to regard their job with less satisfaction than that of their counterparts on the vaccination team. To them the job was monotonous and without sufficient satisfaction, such as seeing in practical terms the results of their efforts. However, the team worked fast and village after village, no matter how large, was completed in record time, sometimes leaving the assessors idle after a couple of hours of work. Normally an assessor could examine between 300 to 500 persons per day and with four assessors working in, say a village of a thousand people or less, the law of diminishing returns soon came into play.

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During the attack phase, there was an acute shortage of personnel, and the programme was forced to use one man for the assessment. This man was supplied with a motorcycle instead of a motor car. He was directed to assess three of the four functioning teams, moving at weekly intervals from one team to the other. Whereas a team of four assessors inspected an average of 700 persons per day, the single assessor has been inspecting about 500 persons per day and is fully occupied each working day. The morale of the assessor is very high and he appears to take personal interest in the quality of the work performed. He concentrates more on his job without distraction from team mates. He is directly supervised by the Medical Field Unit Superintendent, who pays him surprise visits.

With a single assessor, the cost of assessment has been considerably reduced. We have concluded that, given the right type of person with dedication and honesty, it is more economical and effective to work with a one-man assessor in a programme such as ours. An assessor could be attached to each team instead of having one assessor for three or more teams. They could rotate from one team to another.

III. ASSESSMENT PROCEDURE

Not all the villages vaccinated during the project are assessed. Each week, a number of villages are scheduled for the assessor by the Medical Field Unit Superintendent. These villages vary in size but they are representative of a given area. Assessment is planned to commence a week after vaccination. The itinerary is arranged so that the assessor inspects an average of about 400 persons per day.

On arriving at the village, the assessor meets the village Head and his Chiefs and explains the object of his visit. Even though this part of the programme had been previously explained in the plan of operation for the area, it must be emphasized to the village leaders that the visit has nothing to do with tax assessment, as the ordinary village man is very sensitive to this sort of head-count. The assessor then proceeds from house to house, armed with his assessment sheet (Annex 1). The householder assembles his dependents. The assessor then inspects the age group of 0-4 years for rate of coverage and for vaccination takes and then proceeds to examine the other age groups (5-14; 15-44; and 45 years and above) for the coverage rate only. It is quite easy to see the vaccination scars, but it is sometimes difficult to elicit facts from the householder regarding the number of children he has. Some regard this information as sacred and in some cases it is against local tradition to reveal the number of children one has. The number of persons actually seen by the assessor is more reliable. To obtain a more complete sample, villages are visited very early in the morning before the farmers go to the farms or late in the evening when they return.

The assessment in the Mid-West is based on housing units. For villages below 1,000 in population, every house is inspected; for villages between 1,000 and 2,000, every other household; for villages between 2,000 and 3,000, every third household, and so on in accordance with the WHO sampling formula. After the data are assembled according to number of houses, a village summary is prepared to show the total number in the houses, the number vaccinated and the percentage coverage for all age groups combined. The other section of the same record shows the number inspected for primary vaccination, the number of vaccination takes and the take rates for children 0-4 years of age (Annex II). This record which is known as the "Village Assessment Result" ie forwarded with the house-to-house assessment sheets to the

Operations Officer. A sketch route map of the village assessed is shown at the beginning of the assessment sheet for each village to direct whoever wishes to cross-check the assessment results.

IV. USING THE ASSESSMENT DATA

As mentioned previously, assessment data may be used in two ways; to identify areas of poor coverage and to assure adequate take rates. Our problem does not seem to be with the latter but with the former. Areas of poor coverage, i.e., below 80%, have been found by the assessment team. Poor coverage has been felt to be due to poor health education and publicity, the Civil War, the general attitude towards vaccination, a previous unpopular campaign, or logistical problems caused by unreliable land and river transport. Some of these problems have been difficult to overcome and should be noted in more detail.

A. Health Education

The State's Health Education Unit is not specifically assigned to the SMP. This Unit has therefore to share its services with other units in the State. Apart from this, the Health Education Unit has no cinema or loud-speaker vans to make their work more effective. The radio which is a popular medium of information is a public corporation outside the control of the State Government. The day-to-day activities of the state-owned newspaper, which is of less importance because of its limited readership amongst the ordinary villagers, are not directed by the State Ministry of Information. Materials for publicity are therefore not usually given the priority they deserve.

B. Attitude Towards Vaccination

The people in many areas are apathetic to vaccination because smallpox has long ceased to be a major health problem and most of them have yet to see a case of smallpox or its aftermath. This is more noticeable in the southern than in the northern parts of the Mid-West, since, in the north, there had been sporadic outbreaks of the disease prior to the project. Most farmers are averse to vaccination because of the reaction, which hampers their work during the farming season.

C. The Civil War

The Mid-West Programme was launched shortly before the commencement of hostilities. The unsettled situation which followed has affected good coverage especially in the eastern and the southern parts of the state. Public gatherings were discouraged and people panicked at the sight of war planes or on hearing rumours of enemy approach. Most of the villages in the war zones have been evacuated and the inhabitants have fled to areas not accessible to or safe for the vaccinators.

D. Previous Medical Campaign

In one area, adverse reactions following BCG inoculations scared away many people who thought we were conducting the same project.

V. FOLLOW-UP TEAM

During the pilot project, the team of assessors was used also as a follow-up team to vaccinate absentees as they did the assessment. The vaccinations performed, however, were limited because they did not visit every village. When we were forced to use one man as an assessor due to shortage of personnel, follow-up vaccinations devolved on the Health Scouts.

The District Council Health Scouts are not under the direct control of the Medical Field Unit, and some District Councils would not allow their Scouts to be used in areas other than their own. The success of follow-up under these circumstances depended on the number and quality of Health Scouts, most of whom work for only three days in the week and whose wages are usually in arrears owing to the poor financial condition of most of the District Councils. Consequently, the vaccination teams have been employed for follow-up six months after the initial mass vaccination. The itinerary is drawn up to show the village, date of the initial programme, number vaccinated, 1963 census population and the percentage coverage. Also shown are the number of absentees during the attack phase. This number is obtained by subtracting the number vaccinated from the 1963 census figures. Added to this is the 4% estimated increase since the 1963 census. This is the number which the team is expected to vaccinate (Annex III). By this system, we hope to improve coverage.

VI. GENERAL OBSERVATION

From the map showing the assessment results on a Divisional basis (Annex IV), it will be seen that there was a decrease in the coverage as the campaign progressed from the north to the south. This could be due to the following reasons:

The Campaign was launched in the north with all the favourable forces at our command. The publicity media gave us full cooperation because the project was new; it was a national programme. After over a decade on the yaws campaign, the Medical Field Unit personnel wanted a change; hence, the staff received the new assignment with enthusiasm. In addition, the people of the area had been experiencing cases of smallpox and there were well-organized health education committees covering one Division in particular. As the campaign progressed towards the south, the enthusiasm became less, first among those concerned with publicity and then with the teams. The Civil War later set in. Further, the riverine areas in the south are not easily accessible, and lack of river transport made health education work difficult.

ANNEX I
ASSESSMENT SHEET
SMALLPOX ERADICATION/MEASLES CONTROL PROGRAMME

VILLAGE OR TOWN ..... DATE OF SURVEY .....

HOUSE NO.	AGE GROUP 0-4 YEARS				5-14 YEARS		15-44 YEARS		45+ YEARS	
	NO.IN HOUSE	NO. VACC.	NO. INSP.	NO. TAKES	NO.IN HOUSE	NO. VACC.	NO.IN HOUSE	NO. VACC.	NO.IN HOUSE	NO. VACC.
TOTAL:										

ANNEX II
VILLAGE ASSESSMENT RESULT
SMALLPOX ERADICATION/MEASLES CONTROL PROGRAMME

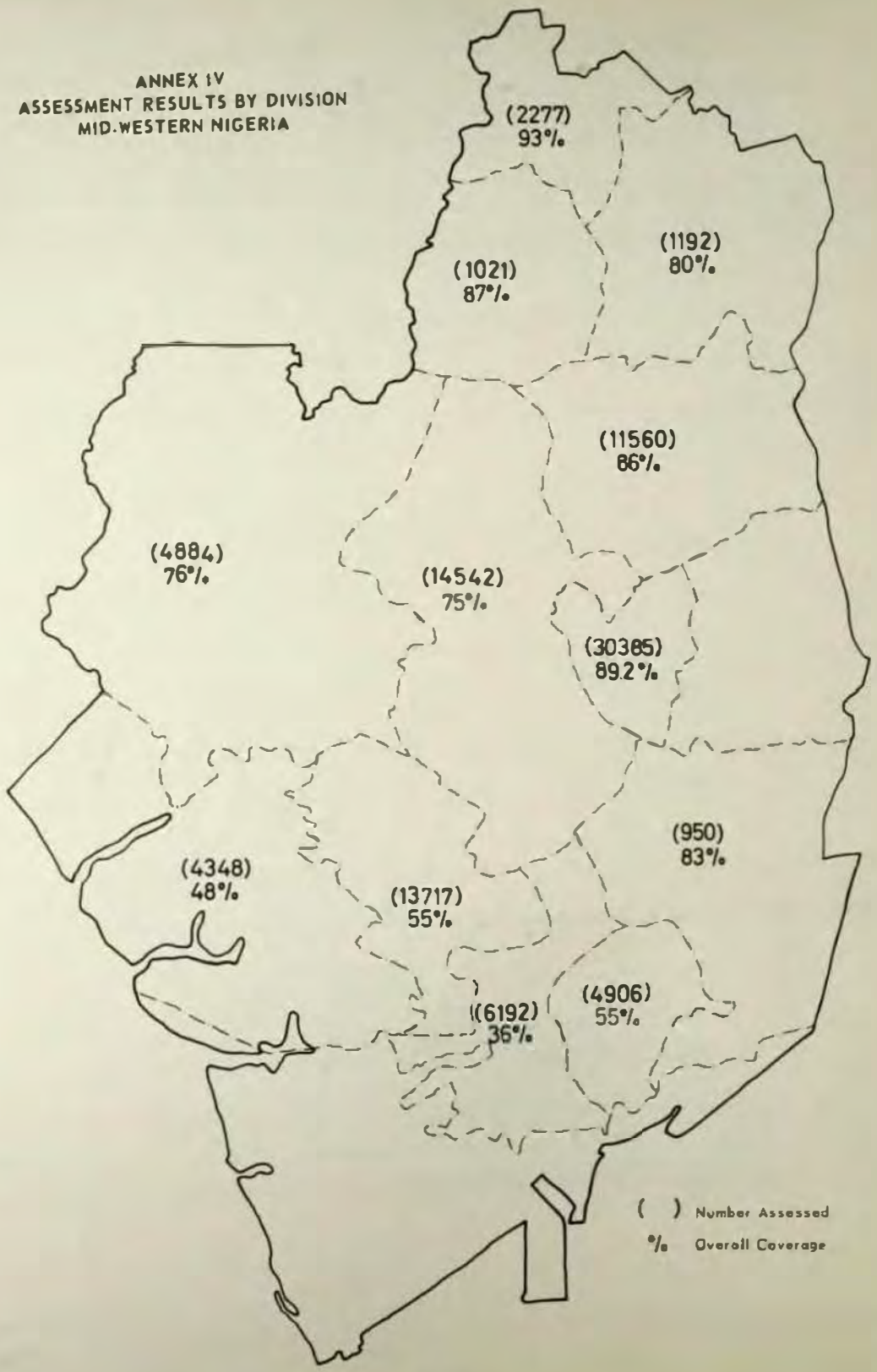
DATE .....

DISTRICT	VILLAGE	NO.IN HOUSE	NO. VACC.	% COVERAGE	INSPECTION 0-4 YEARS		
					PRIMARY VACC.	NO. TAKES	% TAKES
TOTAL:							

ANNEX III
MAINTENANCE PHASE ITINERARY
SMALLPOX ERADICATION/MEASLES CONTROL PROGRAMME

VILLAGE	ATTACK PHASE DATE	1963 POP. CENSUS	NO.VACC. ATTACK PHASE	% COVERAGE	ABSENTEES +4% 1963 CENSUS	DATE FOR MAINTENANCE VACCINATION

ANNEX IV
ASSESSMENT RESULTS BY DIVISION
MID.WESTERN NIGERIA



ASSESSMENT IN THE CENTRAL AFRICAN REPUBLIC

N. Ewen[1]

In the Central African Republic, as in other OCEAC countries, the Smallpox/Measles Programme (SMP) is part of a general health programme run by the Endemic Disease Service (EDS). The EDS is a mobile medical organization which makes periodic visits (prospections) to all parts of the country to provide health services supplementary to those offered by static facilities such as hospitals and dispensaries. Preventive medical care includes vaccinations against smallpox, yellow fever, measles, and tuberculosis (BCG). Examinations are given for such diseases as leprosy, onchocerciasis, and trypanosomiasis; medication is provided for those diseases amenable to treatment.

The EDS consists of a headquarters in Bangui and five medical sectors located throughout the country. Each sector is headed by a physician and staffed by 60 to 75 nurses, drivers, and labourers. The current programme calls for mobile teams to visit all parts of the country at least once every three years. Visits are made more often to larger towns.

The possibility of establisbing an assessment programme to evaluate smallpox vaccinations was first considered in 1967. Trial surveys showed the usefulness of an assessment programme. In one sector an inquiry revealed low coverage among children less than a year old; in Bangui a survey revealed low coverage among certain occupational groups. In other areas surveys showed good coverage among all groups, verifying what had previously been only an assumption.

Ideally we would have liked to establish one or more independent teams of thoroughly trained, conscientious individuals able to cover all areas of the country using a statistically valid sampling method. However, transportation for one full-time assessment team, or two or three part-time teams, was simply not available. Even had trucks been available, maintenance and gasoline costs would have been prohibitive in view of the considerable distances involved. Financial problems are even greater today. Consequently C.A.R. has not, and probably will not be able to develop a full-time, independent assessment programme.

Because of these problems, a programme adapted to the means of the EDS was introduced. Under this programme, the Medecin-Chef of each sector performs one assessment per month in those months when teams are on prospection. Each physician obtains and evaluates the results of his team's work and makes whatever changes are necessary or possible. Coverage and take rates for smallpox vaccinations are compiled, and a report is later forwarded to the Director of the EDS.

THE SAMPLE

The village chosen is one vaccinated by a team 6 to 8 days earlier. The selection is thus limited to 10 to 15 neighbouring villages vaccinated over a 3-day period. The choice is narrowed further by the fact that assessment can only be carried out on a limited number of days per month. The Medecin-Chefs are often busy supervising their teams or working in sector headquarters, which means that surveys can only be made when they have time to conduct them.

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Having arrived in a village, a choice must be made of which persons to examine. The size of the village is estimated, and every 2nd, 3rd, or n-th house is then visited until an adequate sample is obtained. If only a small number of people are present, a second or third village is visited. To avoid counting only those persons who voluntarily approach to present their arms for inspection, care is taken to search out all persons in the sample houses.

Our assessment procedure has several drawbacks: (1) it is not a true random sample; (2) even if the village was chosen at random, and even if the number of persons seen in the village was adequate to draw valid conclusions, the number of villages sampled is too small to give a representative picture of the area as a whole. In general, an entire sub-prefecture is vaccinated in a two or three week period, with the total number of vaccinees ranging from 5,000 to 20,000. A sample of 200 to 300 people from one or two villages is not sufficient for this large population which is dispersed in dozens of small villages.

FINDINGS

Table I presents the results of some of the spot assessments conducted in the five sectors in C.A.R. Some of these were performed by the NCDC Medical Officer or Operations Officer, others by the Medecin-Chefs. The reports are grouped in three categories: the first presents results in areas where vaccination take rates on all persons were recorded; the second where only primary rates were determined; and, finally, those in which take rates for children 0 to 4 years were evaluated. These three categories exist because when assessments were first introduced, no distinction was made between primary vaccination and re-vaccination. Current policy is to determine take rates only among primovaccinees, a procedure which includes, by and large, children aged 0-4 years, and excludes virtually all adults.

In areas where rates were based on all vaccinees, take rates ranged from 76-97%, with an average of 81%. Since this constitutes a mixture of both primary vaccinees and revaccinees, it is impossible to make any definitive statement about vaccination effectiveness.

The take rates for primary vaccinees in the first three sub-prefectures (6,7,8) are satisfactory. The take rates in M'Boki (10) are low; the reasons for the poor results are unknown. The 92% rate in Bimbo (9) was in an area where the multiple pressure technique was employed.

The results in the final section include take rates among children 0-4 years old. For the most part, the children are primary vaccinees, with perhaps 10 to 15 percent of the total representing revaccinees.

Overall vaccination coverage is 90% by assessment figures (Table II). Because of shortcomings in the sampling technique, this figure cannot be considered as more than an approximation. Unless a truly random sampling procedure is used, an evaluator cannot expect to see a representative portion of the community. Persons who are present in the village on vaccination day are often likely to be those present on assessment day. Conversely, those absent on vaccination day (workers, farmers, hunters) are also likely to be absent when an assessment is performed.

In the first column in Table II, vaccination coverage based on official population figures is shown. Among the 49 sub-prefectures, there are probably some whose census figures are acurate, but which ones are reliable is unknown. When, in two sub-prefectures (4 and 14) it is possible to vaccinate 147% and 102% of the census population, it is difficult to have confidence in the 80 and 90% results obtained in other areas. Reasonable though these figures seem, they are based on censuses compiled with the same methodology used for areas where coverage exceeded 100%. One

must be cautious in using official population figures to evaluate the prospection/ vaccination programme.

If the 90% result based on spot assessments is accepted as indicative of good coverage, to what can success be attributed? Several factors are involved: (1) EDS prospections have historically been successful. There are no known groups opposed to vaccination, and the influence of authority figures such as village chiefs, and sub-prefects remain fairly strong. (2) Prospection teams have great appeal in a country where in many areas the only medical care available is provided by the EDS. Also, the arrival of anyone in a remote village is an infrequent event, and the diversion thus provided probably helps to attract persons to vaccination sites. (3) Official papers, including vaccination certificates, are important in the country. In 1968, the Medecin-Chef of one sector learned that some villagers present in a vaccination line were from a neighbouring sub-prefecture. They explained that in order to obtain other official papers (driver's licenses, etc.), they needed current vaccination certificates. Although this type of stimulus is exceptional, it is an indication of the utility of certificates and the role they can play in the operation of a successful prospection programme.

OTHER CONTROL MEASURES

Current policy is to schedule another complete prospection or a complementary campaign if coverage is less than 50%. Although this is a very low standard, it is not possible to justify the expenses of a second campaign unless results are extremely poor.

Special investigations resulting from reports of certain diseases provide an opportunity for the EDS physicians to evaluate conditions in their sectors. For example, there have been several reports of suspected smallpox in recent years. On each occasion an immediate investigation was conducted, revealing all cases to be chickenpox. Reports of meningitis, sleeping sickness or an increased incidence of leprosy have also led to special investigations. Though all of these inquiries have a specific objective unrelated to general assessment, each investigation allows sector physicians to evaluate their overall prospection programme. Even if no special assessment report is prepared, a quick scar survey can be made.

There are many sources of reports of suspected disease. Villagers themselves, through village chiefs and sub-prefects, sometimes provide information. Nurses in dispensaries and first aid posts also transmit information. Leprosy control personnel follow regular, fixed circuits and are able to report on unusual outbreaks of disease. Finally, physicians assigned to hospitals in several interior towns are good sources of information. Through investigation of reports of various diseases, the surveillance system serves to stimulate assessment.

CONCLUSION

The Central African Republic has had no cases of smallpox since 1962; scars suggestive of past smallpox infection are rare among villagers. At least one vaccination scar is present on virtually all adults; in such a well vaccinated population there appears little danger of an epidemic in the event of an introduced case. In addition, villagers continue to participate when prospections are conducted. When these factors are considered in combination with the fact that several limited forms of assessment are in operation, there seems to be little justification for the creation of a formal assessment team whose findings in any case probably could not be acted upon. It is primarily a question of money.

Assessment is undoubtedly more vital for a country where no health structure exists, but for the Central African Republic, special teams for this purpose are certainly not a necessity. Our record with respect to smallpox supports this contention, for the disease has been eradicated. If results, not technique, are what count, our system cannot be strongly criticized.

TABLE I

ASSESSMENT OF COVERAGE

		No. Examined	No. With Takes	% With Takes
I.	Take rates determined in all persons irrespective of vaccination status			
1.	Markounda	211	204	97
2.	Bambari	419	373	89
3.	Bakouma	420	335	80
4.	Rafai	120	856	76
5.	Berberati	78	59	76
II.	Take rates determined in primary vaccinees only			
6.	M'Baki	39	39	100
7.	Kembe	101	99	98
8.	Mingala	45	44	98
9.	Bimbo	51	47	92
10.	M'Boki	40	36	90
III.	Take rates determined in children 0-4 years of age			
11.	Alindao	359	347	97
12.	Bozoum	19	18	95
13.	Bossangoa	107	101	94
14.	Bria	124	116	93
15.	Paoua	137	123	90

TABLE II

ASSESSMENT OF COVERAGE

Locality	Assessment Data (%)	Census Data (%)	0-4 Yrs.		5-14 Yrs.		15-44 Yrs.		45+ Yrs.		Total	
			No. Persons	% Vac.	No. Persons	% Vac.	No. Persons	% Vac.	No. Persons	% Vac.	No. Persons	% Vac.
1. Markounda	84	87	84	89	58	100	91	82	18	17	251	84
2. Bambari	90	93	72	96	98	91	261	90	32	81	463	90
3. Bakouma	88	97	77	64	73	95	286	94	44	77	480	88
4. Rafai	95	147	141	92	240	95	481	97	316	93	1178	95
5. Berberati	91	97	23	96	16	94	45	92	13	76	97	91
6. M'Baki	96	91	42	98	44	98	63	95	15	93	164	96
7. Kembe	95	84	78	94	28	100					106	95
8. Mingala	89	87	51	98	119	91	73	85	10	60	253	89
9. Bimbo	83	86	54	94	44	93	115	76	34	79	247	83
10. M'Boki	86	69	8	88	105	96	71	86	1	100	185	86
11. Alindao	95	89	378	95	422	98		93	137	93	1546	95
12. Bozoum	92	86	22	86	51	94		98	26	81	159	92
13. Bossangoa	95	84	108	99	177	97		95	82	89	555	95
14. Bria	93	102	136	91	128	94	164	98	50	86	478	93
15. Paoua	96	79	142	96	203	97	201	95	81	90	627	96

ASSESSMENT OF VACCINATION COVERAGE AND SMALLPOX IN FIVE AREAS OF WEST AFRICA - A SUMMARY OF TERMINAL ASSESSMENT RESULTS

R. H. Henderson[1], H. Davis[2], D. Eddins[3]

I. INTRODUCTION

In 1968 and early 1969, staff from the Regional Office of the Smallpox/Measles Programme carried out evaluations of the attack phases of several countries. During the evaluation, a survey of the population residing in vaccinated areas was conducted to determine vaccination coverage (based on the history of vaccination by jet injector) and the proportion of persons with vaccination scars and pox scars. This report summarizes the data obtained from five such surveys which were conducted in areas highly endemic for smallpox prior to the initiation of the programme, and in which smallpox incidence has subsequently fallen to extremely low levels. These areas are Sokoto and Katsina Provinces in Northern Nigeria, Western Nigeria, Niger, Dahomey and Togo (Figure 1). Excluded from the sample within these areas were those localities not vaccinated by the programme at the time of the survey. In Niger, a small vaccinated area inhabited almost solely by desert nomads was also excluded for logistical reasons.

II. METHODS

A random sample of at least 1100 persons was drawn from each area evaluated, using a one stage cluster sampling technique specifically adapted for use in rural West Africa. The surveys were designed to provide results accurate to within $\pm$ 10% except for a one in 20 chance. A detailed description of the methodology is presented in Appendix I.

The surveys were directed at villages which, except in Western Nigeria, contain 90% or more of the population of the assessed areas[4]. The social class within these villages is more or less uniform. In Western Nigeria, the most highly urbanized area in West Africa, about 60% of the population reside in towns of over 5,000 persons. A separate survey of towns was conducted in the West which is not presented in detail in this report. Although the definition of the size of aggregation of persons which constituted a village differed in each survey (Table I), the results are believed to be broadly representative of the rural populations of each of the five areas.

The sample surveys were conducted by five to eight assessment teams, each led by an NCDC/USAID advisor or a national professional staff member, and were generally completed within two weeks. Most of the team leaders came from countries other than the one being assessed. The authors led at least one assessment team in each of the surveys, and personally trained all other team leaders and interpreters.

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[4]From available National Census data, 1961-1963

Each person sampled was interviewed and examined by one of the assessment team leaders. All questions were asked in a local language in which both the assessor (or his interpreter) and the person sampled were fluent. To determine vaccination coverage during the programme, all persons were asked "Have you ever been vaccinated?" Those who responded affirmatively were then asked, "When was your last vaccination?", and "How were you vaccinated?" If the person did not understand what was meant by the third question, the assessor was then instructed to ask "Were you vaccinated by the jet injector or with the needle?" There were usually words in the local language for both "jet injector" and "needle," the latter term being used to denote the device used in performing multiple puncture, multiple pressure or "scratch" vaccinations. If the person interviewed was still uncertain about the meaning of the question, a pantomine was performed, first making the motion of pushing a foot pedal while bringing the right hand towards the person's left arm as though holding an injector, and then making the motions associated with a "scratch" vaccination. In the vast majority of cases, the answers given were unequivocal, and left no doubt in the assessor's mind whether or not the person had been vaccinated and by which method.

In looking for smallpox vaccination scars, both arms were examined. In a few instances, a parent would indicate that his child had been vaccinated on the thigh, in which case the thigh was examined. In certain areas many persons had been vaccinated in BCG campaigns. Since these vaccinations were usually given on the forearm, there was little difficulty in distinguishing them from smallpox vaccination scars. Occasionally, burn scars intentionally induced as a sign of bravery, and traditional skin tatooing or scarring were a source of confusion.

A person was recorded as having smallpox scars if he had at least five pock marks of two millimetres or more in diameter on his face.

III. RESULTS

A. General

The percentage of selected sample sites which could be completed is shown in Table 2. In Northern Nigeria, 134 sites were selected since Sokoto and Katsina Provinces were each surveyed separately. The results presented in this report combine the two surveys by weighing the results from each in proportion to its population (4,500,000 persons for Sokoto, 2,650,000 persons for Katsina). Six of the assigned sites were inaccessible owing to the onset of the rainy season, and one site was inadvertently overlooked by one of the assessment team leaders. These missed sites would have been accessible to the vaccination teams during the dry season (when most of the vaccinating was done), and the bias introduced by the incompleteness of the survey is probably negligible.

Two surveys were also carried out in Western Nigeria, and their results have similarly been combined. One of these two areas had been more severely affected by the recent rainy season than had the other, making the assessment work slower and more difficult, with the result that only 37 of the 67 assigned sites were completed. Of the 30 sites which were missed, 18 were omitted because of insufficient time, 11 could not be reached, and one village which had been selected was unknown to all persons asked of its whereabouts, Fortunately, this difficult area contained only 18% of the total village population of the Western State. The areas which were inaccessible to the assessors should have been accessible to the vaccination teams at the time of the mass campaign and thus the bias introduced is believed to have been small. It was possible to reach all but two of the

67 sites selected in the second area surveyed in the Western State, which contained 82% of the population.

In Niger, all sites were visited, but the data for one site were misplaced. All sites were surveyed in Dahomey and Togo.

The percentage of the sampled population who lived in small villages, (arbitrarily defined as being less than 500 persons), and large villages (500 or more persons), is presented in Table 3. Data accumulated since the beginning of the Programme[5] indicates that small villages can be important in sustaining smallpox transmission. Additionally, it has often been found to be more difficult to achieve high levels of vaccination coverage in small villages, since they are usually the least accessible, and, in programmes which do not visit every village, their inhabitants, are the ones who are usually asked to walk the fartherest distance to be vaccinated. Thus, it seemed worthwhile to compare the survey results from small and large villages.

B. Number and Age Distribution of Sampled Population

The number of persons examined in each survey is presented in Table 4. The survey design was adequate to provide the estimated minimal sample size for each age group (see Appendix) with the exception of the 45 and over age group in Dahomey and Togo, and 15-44 year old males in Niger. In only one instance, determination of vaccination coverage in the 45+ age group in Dahomey was the number of persons obtained less than the actual minimal sample size needed which resulted in slightly diminished accuracy in this group.

The age distribution of the population which was examined is presented in Tables 6 through 10. The age distribution of the population of West Africa (United Nations Demographic Yearbook 1965) is also presented for comparison. In all surveys, the percentage of males between the ages of 15 and 44 was less, and the percentage of females slightly more, than would have been expected from the published age distribution of the population of West Africa. All surveys also showed a slight excess in the percentage of children aged 0-4 who were sampled. All rates for vaccination coverage, frequency of vaccination scars, and smallpox scars were age adjusted, using the West African age distribution as a standard.

C. Proportion of Population with a History of Vaccination by Jet Injection

Since the Smallpox Measles Programme is the first in West Africa which has used jet injectors in mass smallpox vaccination campaigns, the history of having received a smallpox vaccination with a jet injector was a useful marker for assessing programme vaccination coverage.

In Niger, Dahomey, and Togo, however, a USAID sponsored measles vaccination programme which used jet injectors to vaccinate children from 6 months through 5 years had been in operation for about two years prior to the first smallpox campaigns using injectors. While this conceivably could have been a source of confusion with respect to vaccination history in children from four through ten years, the assessors' subjective impressions were that this was not a problem.

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[5] See the SEP Report issued periodically by the Smallpox Eradication Programme, NCDC, Atlanta, Georgia, USA

Vaccination coverage rates achieved in the programme (Table 5) were highest in Northern Nigeria, which had an overall rate of 92.9%. The lowest rate, 61.9%, was observed in Western Nigeria, and the other three areas had intermediate values. Age specific rates by area (Tables 6 through 10) show a similar pattern. The lowest rate of vaccination coverage was observed in children less than a year of age and the next lowest rate in the 45+ age group; the highest vaccination coverage was observed in the 5-14 year age group; the 1-4 and 15-44 age groups had intermediate values. Differences in vaccination coverage attributable to sex were not striking, although working males (15-44 years) were less completely vaccinated in Western Nigeria, and females in the 5-14 and 15-44 age groups were less completely vaccinated in Dahomey.

In all areas except Niger, where no differences were observed, coverage rates in small villages were 8-10% less than those in large villages (Table 3). This difference was significant at the .01 level by the chi square test.

This pattern was not observed, however, in all age and sex groups. The 1-4 year age group, in fact, had slightly higher coverage rates in small villages in all areas except Togo. The most consistent differences were seen in the 15-44 year age group in which vaccination coverage in all areas was lower in small than in large villages. Even here, coverage in males was markedly lower in Togo; coverage in females was markedly lower in Northern Nigeria, while in Dahomey, the coverage in both was significantly less. Although the differences are generally small, there were generally higher levels of coverage in females than males in small villages, while males had higher levels of coverage than females in large villages.

D. Proportion of Population with Vaccination Scars

The highest vaccination scar rates were observed in Togo (86.5%), while Western Nigeria again had the lowest (74.2%). Age specific rates by country are shown in Tables 6-10. In Northern Nigeria, Western Nigeria, and Niger, the rates follow the pattern described for vaccination coverage: the lowest vaccination scar rates are observed in the under one and 45+ age groups, the highest rates are observed in the 5-14 age groups; the 1-4 and 15-44 age groups have intermediate values. In Togo, however, the frequency of vaccination scars increased with increasing age. In Dahomey, the same pattern is seen, except for the 45+ age group, which has an intermediate rate for vaccination scars. As with the vaccination campaign coverage rates, the differences in scar rates by sex are not striking, although a lower frequency of scars, as with vaccination coverage, was observed in 5-14 year old females in Dahomey. Lower scar rates were also observed in females 45 and over in Northern Nigeria.

Vaccination scar rates were less consistently related to village size than were vaccination coverage rates. Small and large villages had the same rates of vaccination scars in Northern Nigeria and Niger, and Western Nigeria actually had higher vaccination scar rates in small than in large villages - a reversal of the pattern observed with vaccination coverage. Togo and Dahomey showed lower scar rates in small than in large villages. These differences were significant at the .01 level, and were largely accounted for by the 15-44 and 45+ age groups. Differences by sex and village size were not observed with respect to vaccination scar rates.

E. Proportion of Population with Scars of Smallpox

The highest frequency of smallpox scars (19.4%) was observed in Northern Nigeria. Western Nigeria (9.6%), and Dahomey (8.1%) had the next highest rates; Niger (5.3%), and Togo (3.0%) had the lowest rates. The differences between these three groups is significant at the .01 level. In most areas, few scars were observed among those less than five years of age. Rates increased with age thereafter, reaching maximal values in the 15-44 and 45+ age groups. While higher rates were observed in all areas among 15-44 year old males than among females, the difference was negligible in Northern Nigeria.

Smallpox scar rates were not consistently related to village size indicating that smallpox had afflicted the populations of small villages in these areas just as often as it had afflicted the populations of large villages. The greatest difference (8.6%) was observed in Northern Nigeria but this was probably due to an artifact in the analysis; the scar rates for all villages was 19.4% while the rate for villages with known size was only 14.1% indicating that persons from sampled villages of unknown size had a higher scar rate than those from sampled villages of known size. Northern Nigeria and Dahomey showed higher scar rates in small than in large villages (significant at the .01 level), Western Nigeria and Niger showed higher rates in large villages (significant at the .05 level), and no differences were seen in Togo. The frequency by sex of smallpox scars was similar in small and large villages.

IV. DISCUSSION

A. Proportion of Population with History of Vaccination by Jet Injector

It has been observed in West Africa that Smallpox outbreaks can occur in populations with immunity levels of over 88%[6], so long as the few smallpox susceptibles which exist have intimate contact with one or more cases, and that smallpox transmission can stop in populations with immunity levels of only 53%[7]. It is the frequency and intimacy of exposures to susceptibles which determines whether smallpox transmission will occur. However, the overall proportion of susceptibles does correlate with the probability that transmission will take place and this measurement has been found to be useful in defining minimum standards for the level of vaccination coverage which should be achieved in mass campaigns. The programmes in West and Central Africa have established as a minimum standard the figure of 80%. The survey results indicate that at least 80% of the population was vaccinated in Sokoto and Katsina Provinces, Niger, and Togo. In fact, the actual coverage levels achieved by the programmes can be considered to be 3 to 5% higher than those determined by the surveys, owing to the addition of newborns following the mass campaign. However, neither Dahomey nor Western Nigeria achieved 80% vaccination coverage.

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[6]Thompson, D. Faith Tabernacle Smallpox Epidemic, Abakaliki, Eastern Nigeria (unpublished paper)

[7]Henderson, R. H. and Yekpe M., Smallpox Transmission in Southern Dahomey, Am. J. of Epid. 90(5):423-428, 1969.

The most successful programme was that of Northern Nigeria. This is thought to have been due to the influence of the traditional authorities, the Emirs, with their highly organized and centralized system of local government. Information about the programme was effectively transmitted to the concerned population, and at the command of the local authorities the vast majority of people from surrounding villages came to a central vaccination point, and sometimes waited for hours for the vaccination team to arrive. An additional factor contributing to the programme's effectiveness was the fact that mass campaigns had been infrequent in the past, and the populations were eager to be vaccinated.

The lowest levels of vaccination coverage, on the other hand, were observed in Western Nigeria. As the direction, the calibre of the vaccination teams, and the calibre of the team supervisors of the programme in the West appeared to be comparable, if not superior to that in Northern Nigeria, it seemed that this difference was most readily explicable on the basis of differences in the ability of local authorities to motivate villagers to be vaccinated. Western Nigeria teams made the effort to visit every village, realizing that traditional authorities would have little success in motivating the people to travel to another village to be vaccinated. In spite of this, many villagers, informed of the team's schedule, chose not to be present when they arrived. Additionally, the system of advance notification was not very effective so that many other persons were unaware that the team was coming. Occasionally, entire villages fled from the vaccination teams. This seemed to be confined to small relatively isolated villages in which the residents had a general suspicion of strangers. This did not seem to be caused by a specific fear of vaccination. Such behaviour was rarely observed in the North. Notably, Western Nigeria achieved a vaccination coverage rate of 83.1% in towns of over 5,000. More effective advance publicity carried out in urban areas may have accounted for this. In Niger, Dahomey and Togo, an interplay of several factors appeared to account for the intermediate levels of vaccination coverage which were observed.

In all programmes, similar factors contributed to the differences observed in the age specific rates of vaccination coverage. The low rates in children of less than one year of age, as found in the survey were principally due to the fact that the majority of the unvaccinated had not been born at the time of the mass campaigns. Among the 45+ age group, which had the next lowest level of vaccination coverage, a considerable proportion had already been vaccinated several times or had had smallpox, and considered vaccination to be unnecessary. Others simply felt that they were too old to be bothered with it. The 5-14 year olds were best vaccinated in the programme presumably owing to their curiosity and their mobility. The arrival of the vaccination teams was a big event in the life of the village, and these children made every effort to be on hand to witness it. The somewhat lower coverage in the 1-4 year age group was probably related to the dependence of this group on a parent or older sibling to bring them for vaccination. The 15-44 age group was the one in which absenteeism from the village was most frequently responsible for their not being vaccinated. This absenteeism tended to affect males more than females.

Lower levels of vaccination coverage were generally observed in small villages. The fact that this difference was most pronounced in Northern Nigeria is most probably related to the campaign strategy, in which the vaccination teams visited only the larger villages, and requested those in the surrounding smaller villages to come to them. In all of the other areas, the attempt was made to visit every village. However, in Western

Nigeria and Niger, approximately 10% of the villages which were sampled had not been visited by one of the vaccination teams. These villages were predominantly small. Only two of the 135 sampled villages in Dahomey and Togo had not been visited by a vaccination team, and yet the discrepancies in coverage between small and large villages were more pronounced in these latter countries than they were in Western Nigeria and Niger. It would appear that other factors, such as the effectiveness of advance publicity, the willingness to cooperate with persons not well known to the village, or perhaps the normal rates of absenteeism, played the major role in accounting for this observed difference. Additional study would be required to clarify the relative importance of the various contributing factors.

B. Proportion of Population with Vaccination Scars

Smallpox vaccination scar rates were close to or exceeded 80% in all areas surveyed. Only two, Western Nigeria and Niger had rates below 80% and these were 78.8% and 75.2% respectively. Examination of the specific vaccination scar rates, however, reveals that none of the areas had rates above 40% in the under one year age group, and only Northern Nigeria and Niger had rates of over 80% in the 1-4 year age group. These findings emphasize the rapidity with which new susceptibles enter the population, and underline the importance of following the attack phase in these areas with a maintenance phase directed specifically at the 0-4 age group. All areas had scar rates of 80% or over in the 5-14 and 15-44 year age groups in both sexes with the exception of the 15-44 year old males in Western Nigeria, whose rate of 70.2% reduced the age group total to 78.2%. For the 45+ age group, Dahomey and Togo were the only areas in which scar rates of over 80% were observed.

In Western Nigeria, Dahomey and Togo, the number of persons who stated that they had been vaccinated by jet injector was less than the number who actually had a vaccination scar, and it is evident that past vaccination programmes have covered a proportion of the population which the jet injector teams missed. In Northern Nigeria and Niger, however, a significant number of persons lacked scars although stating that they had been vaccinated during the recent programme. This finding could have resulted from persons stating that they had been vaccinated by jet injector when they had not been, or could have been caused by the administration of a certain number of ineffective vaccinations by the teams. The second explanation appears to be the more likely. The best method for documenting this would be to determine vaccination take rates 6-8 days following vaccination. While this is being done with increasing frequency by the individual programmes, it had not been done often enough to permit an accurate comparison of take rates in the five surveyed areas. The fact that scar rates showed less dependence on village size than did vaccination coverage rates, suggests that past programmes achieved greater success in reaching small villages than has the present programme.

In appraising overall immunity to smallpox, several calculations were compared. In the survey in Niger, two indices were calculated. In one, all persons with a vaccination scar were considered to be immune; in the other, persons who had a vaccination scar and a history of vaccination within the past 10 years, and persons who had smallpox scars or scars of variolation were considered to be immune.

Among 2,726 persons, 77.3% had a vaccination scar, while 76.0% had either a vaccination scar and a history of vaccination within the past 10 years, or had smallpox or variolation scars. This difference is not significant at the .05 level.

In Northern Nigeria, information was not obtained regarding variolation scars or the proportion of persons with vaccination scars who had been vaccinated within the past ten years. Lacking this, a comparison was made between smallpox immunity as measured by the presence of a vaccination scar and/or smallpox scars and as measured by the presence of a vaccination scar alone. In a sample of 5,748 persons in Sokoto and Katsina Provinces, 88.9% had a vaccination scar and/or smallpox scars, while 83.8% had a vaccination scar. In a sample of 1428 persons in villages in Western Nigeria, 78.2% had a vaccination scar and/or smallpox scars, while 75.2% had a vaccination scar alone. These differences are significant at the .01 in Northern Nigeria, but not significant (at the .05 level) in Western Nigeria.

The data suggest that, except for Northern Nigeria where the smallpox scar rates are relatively high, an index of smallpox immunity based on the presence of a vaccination scar provides a reasonable estimate of smallpox immunity in the population.

In analysis of smallpox susceptibles (defined as persons lacking a vaccination scar) (Table 11) indicates that the 0-4 age group accounts for 32.2% of the total susceptible pool, while the 15-44 age group accounts for 35.7%. This, of course, was the situation which existed at the time of the surveys. Without maintenance programmes, the 0-4 age group will increase its contribution to the total susceptible pool by some 10% during the first year, and thereafter by a percentage which diminishes slightly each year as the total pool of susceptibles continues to grow.

Although these programmes have achieved a remarkable success in reducing smallpox transmission to very low levels, the survey results leave no doubt that disease which is re-introduced from outside the area, or which may still be smoldering in an undiscovered pocket within the area, still has a good possibility of becoming re-established as an endemic disease, particularly as the influx of newborns continues to increase the proportion of smallpox susceptible persons. While maintenance programmes can be expected to provide some measure of defense against this occurrence, they will clearly need to be supplemented by vigorous investigation and control of all suspect cases, and with a programme aimed at improving smallpox case reporting.

C. Proportion of Population with Scars of Smallpox

Northern Nigeria has for many years been regarded as a major focus for smallpox, and the fact that the smallpox scar rates observed in Sokoto and Katsina Provinces were more than double the rates observed in other areas supports this view. It is particularly of interest that the Niger population, a large proportion of whom live in a fertile strip of land bordering Northern Nigeria have such a low rate of smallpox scars. The fact that a higher frequency of smallpox scars was not observed in Niger probably relates to the success of past vaccination programmes which have concentrated for many years on protecting this border population.

Western Nigeria and Dahomey appear to have shared a similar smallpox problem: the Yoruba and Fon tribes in the two areas mingle across their common border, and share many beliefs, including the belief in a god of smallpox. While travelers to or from the North may have augmented the incidence of smallpox in these areas, it seems likely that this has been an important focus in its own right in the past.

Smallpox scar rates observed in Togo were the lowest in the five areas. Smallpox in Togo is proving to be a difficult adversary, however, since, in spite of having the highest vaccination scar rates, it has continued to be plagued by outbreaks of smallpox which have turoed up in pockets of poorly vaccinated persons. Togo is one of the only areas of West Africa where smallpox incidence actually increased in 1968, in marked contrast to the majority of countries which were experiencing a decrease in incidence.

IV. SUMMARY

Smallpox incidence in West and Central Africa has declined dramatically since attack phase vaccination programmes have been carried out. Sample surveys were carried out in 1968 and early 1969 in Sokoto and Katsina Provinces in Northern Nigeria, Western Nigeria, Niger, Dahomey and Togo. Only in Western Nigeria and Dahomey did less than 80% of the population give a history of having been vaccinated during the attack phase, and vaccination scar rates were above 75% in all areas sampled. Children under age of five years accounted for 32.2% of all susceptibles at the time of the surveys, and will account for some 40% of all susceptibles within a year following the surveys in the absence of a maintenance vaccination programme.

The highest rate of smallpox scars (19.4%) was recorded in Sokoto and Katsina Provinces. Western Nigeria and Dahomey had intermediate rates (9.6% and 8.1% respectively), while Niger and Togo had the lowest rates (5.3% and 3.0%).

Table 1. Population Centres Defined as "Villages" for Purposes of Sample Surveys

Country	Definition of a "Village"
Northern Nigeria	All population centres of 10,000 or less persons
Western Nigeria	All population centres of 5,000 or less persons
Niger	All population centres of 1,000 or less persons
Dahomey	All population centres excluding Cotonou, (pop. 110,000), Porto-Novo, (pop. 70,000), Abomey, (pop. 23,000), and Ouidah (pop. 19,000)
Togo	All population centres excluding Lome, (pop. 121,000)

Table 2. Percentage of Selected Sample Sites which were Completed

Area	Sample Sites Selected	Sample Sites Completed	Percent Completed
Northern Nigeria	134	127	95
Western Nigeria[1]	134	92	90
Niger	67	66	99
Dahomey	68	68	100
Togo	67	67	100

[1]Two areas were surveyed. Area one contained 82 percent of the total village population. Sixty-five of 67 sites were completed (97 percent). Area two contained 18 percent of the total village population. Thirty-seven of 67 sites were completed (55 percent). The data presented in this report were obtained by weighting the results from area one by 82 percent and the results from area two by 18 percent.

Table 3. Percentage of Sampled Population Residing in Small (1-500) and Large (501+) Villages

Area	Percent Residing in Small Villages (under 500)	Percent Residing in Large Villages (500+)
Northern Nigeria	26	74
Western Nigeria	51	49
Niger	61	39
Dahomey	21	79
Togo	37	63

Table 4. Number of Persons Sampled

	Age Group					
Area	1	1-4	5-14	15-44	45+	Total
Northern Nigeria	138	438	531	1,069	328	2,504
Western Nigeria	89	312	372	731	372	1,876
Niger	64	235	282	426	138	1,145
Dahomey	69	242	243	494	116	1,164
Togo	57	266	265	455	119	1,162

Table 5. Summary of Assessment Results

A. Proportion of Population (age adjusted) with History of Jet Injector Vaccination (in Percent)

	Village Population under 500	Village Population 500+	Total
Northern Nigeria	81.1	90.9	92.9 (88.0)[a]
Western Nigeria	56.3	63.8	61.9
Niger	80.1	77.4	79.3
Dahomey	63.9	72.4	70.4
Togo	74.0	83.7	79.7

B. Proportion of Population (age adjusted) with Smallpox Vaccination Scars (in Percent)

Northern Nigeria	86.5	86.7	84.3 (86.6)[a]
Western Nigeria	80.3	72.4	75.2
Niger	78.0	79.8	78.8
Dahomey	76.0	81.3	80.0
Togo	83.0	91.2	88.0

C. Proportion of Population (age adjusted) with scars of smallpox (in Percent)

Northern Nigeria	20.5	11.9	19.4 (14.1)[a]
Western Nigeria	7.4	11.2	9.6
Niger	4.4	7.2	5.3
Dahomey	12.7	7.1	8.1
Togo	2.6	3.3	3.0

[a] In Northern Nigeria, two of the assessment teams (one working in Sokoto and one working in Katsina Province), did not record the populations of the villages sampled. The figures in parenthesis and, of course, those for which village size is specified, are derived from the 86 sample sites for which the village size was known.

Table 6. Northern Nigeria (Sokoto and Katsina Provinces)
Assessment Results

A. Population Examined

Age	Number Examined Male	Female	Total	Age Distribution of Examined Population (%) Male	Female	Total	Age Distribution of Population of West Africa(%) Male	Female	Total
<1			138 (76)[a]			5.5 (4.4)[a]			4.3
1-4			438 (292)			17.5 (16.8)			14.5
5-14	217	314	531 (379)	8.7	12.5	21.2 (21.8)	13.2	11.9	25.1
15-44	320	749	1,069 (754)	12.8	29.9	42.7 (43.4)	19.7	22.5	42.0
45+	116	212	328 (235)	4.6	8.5	13.1 (13.5)	7.4	6.6	14.0
TOTAL			2,504 (1736)			100.0 (99.9)			99.9

Village Population under 500			Village Population 500-10,000			Total		

B. Proportion of Persons (age adjusted) with History of Jet Injector Vaccination (in Percent)

Age	Male	Female	Total	Male	Female	Total	Male	Female	Total
<1			31.8			51.0			69.6 (46.0)[a]
1-4			94.9			93.3			95.4 (93.7)
5-14	100.0	93.1	95.8	96.8	96.3	96.7	98.7	96.2	97.1 (96.5)
15-44	86.1	65.0	73.6	92.3	93.6	93.2	91.4	94.4	93.6 (88.1)
45+	77.8	78.0	78.5	89.2	81.3	84.3	88.2	93.5	88.6 (82.8)
TOTAL			81.1			90.9			92.9 (88.0)

C. Proportion of Persons (age adjusted) with Smallpox Vaccination Scars (in Percent)

<1			18.8			45.4			61.2 (38.5)[a]
1-4			91.9			89.6			89.1 (90.2)
5-14	83.5	98.5	92.1	98.6	96.3	97.2	91.9	93.9	93.1 (95.9)
15-44	94.6	89.5	91.0	90.8	86.4	87.5	86.5	82.9	83.5 (88.4)
45+	79.6	77.8	78.5	80.0	73.0	75.7	80.2	70.1	73.8 (76.4)
TOTAL			86.5			86.7			84.3 (86.4)

D. Proportion of Persons (age adjusted) with Scars of Smallpox

<1			0.0			0.0			0.0 (0.0)[a]
1-4			2.3			0.7			2.3 (1.1)
5-14	2.9	7.3	5.7	0.4	2.9	1.8	9.6	7.5	8.6 (2.8)
15-44	39.1	34.8	36.2	23.1	19.2	20.5	30.6	29.6	30.0 (24.6)
45+	19.3	29.0	25.2	36.3	10.9	19.4	33.5	28.0	30.7 (20.9)
TOTAL			20.5			11.9			19.4 (14.1)

[a] In Northern Nigeria, two of the assessment teams (one working in Sokoto and one working in Katsina Province), did not record the populations of the villages sampled. The figures in parenthesis and, of course, those for which village size is specified, are derived from the 86 sample sites for which the village size was known.

Table 7. Western Nigeria
Assessment Results

A. Population Examined

Age	Number Examined Male	Female	Total	Age Distribution of Examined Population(%) Male	Female	Total	Age Distribution of Population of West Africa(%) Male	Female	Total
1			89			4.7%			4.3%
1-4			312			10.6			14.5
5-14	183	189	372	9.7	10.1	19.8	13.2	11.9	25.1
15-44	296	435	731	15.8	23.2	99.0	19.7	22.5	42.0
45+	169	203	372	9.0	10.8	19.8	7.4	6.6	14.0
TOTAL			1876			99.9%			99.9%

	Village Population under 500			Village Population 500 - 10,000			Total		

B. Proportion of Persons (age adjusted) with History of Jet Injector Vaccination (In Percent)

Age	Male	Female	Total	Male	Female	Total	Male	Female	Total
1			34.6%			33.4%			34.0%
1-4			70.4			68.0			69.2
5-14	74.1	62.7	67.0	80.2	83.7	81.9	77.1	81.6	79.9
15-44	50.5	57.1	54.9	51.0	66.0	59.1	50.8	61.6	52.6
45+	36.3	31.7	34.1	54.0	47.0	50.9	48.0	41.1	44.9
TOTAL			56.3%			63.8%			61.9%

C. Proportion of persons (age adjusted) with Smallpox Vaccination Scars (In Percent)

1			38.7%			30.9%			34.0%
1-4			71.3			68.8			69.8
5-14	83.2	81.1	81.9	83.8	90.2	86.9	83.5	85.5	84.1
15-44	88.0	89.0	88.6	64.1	80.0	72.4	70.2	84.1	78.2
45+	74.5	74.9	75.0	61.9	64.5	63.5	73.6	68.7	62.4
TOTAL			80.3%			72.4%			75.2%

D. Proportion of persons (age adjusted) with Scars of Smallpox

1			0.0%			0.0%			0.0%
1-4			1.2			0.0			0.6
5-14	0.0	2.6	1.6	4.2	5.8	4.9	2.7	3.8	3.3
15-44	13.9	10.3	11.4	18.5	15.4	17.1	17.1	13.3	15.0
45+	18.6	12.4	15.0	22.7	15.4	20.1	19.5	15.3	17.3
TOTAL			7.4%			11.2%			9.6%

Table 8. Niger
Assessment Results

A. Population Examined

Age	Number Examined Male	Female	Total	Age Distribution of Examined Population(%) Male	Female	Total	Age Distribution of Population of West Africa(%) Male	Female	Total
1			64			5.6%			4.9%
1-4			235			20.5			14.5
5-14	125	157	287	10.9	13.7	24.6	13.2	11.9	25.1
15-44	112	314	426	9.8	27.4	37.2	19.7	22.5	42.0
45+	61	77	132	5.3	6.7	12.0	7.4	6.0	14.0
TOTAL			1145			99.9%			99.9%

	Village Population under 500			Village Population 500 - 10,000			Total		

B. Proportion of Persons (age adjusted) with History of Jet Injector Vaccination (In Percent)

Age	Male	Female	Total	Male	Female	Total	Male	Female	Total
1			2.5%			12.5%			6.5%
1-4			84.0			78.6			81.0
5-14	91.9	93.9	92.7	93.5	88.1	90.5	92.7	92.6	92.6
15-44	79.7	85.4	83.9	86.8	85.3	85.7	82.9	85.5	84.8
45+	68.4	65.4	66.7	34.8	60.0	47.9	54.2	65.3	60.4
TOTAL			80.1%			77.4%			79.3%

C. Proportion of persons (age adjusted) with Smallpox Vaccination Scars (In Percent).

1			2.5%			12.5%			8.5%
1-4			68.3			67.0			67.4
5-14	88.6	89.0	89.3	91.1	93.1	92.2	90.9	89.9	90.3
15-44	91.9	86.4	87.9	92.1	84.4	86.4	92.0	85.9	87.5
45+	57.9	65.3	62.1	76.2	69.2	72.3	63.2	69.9	66.9
TOTAL			78.0%			79.5%			78.8%

D. Proportion of persons (age adjusted) with Scars of Smallpox

1			0.0%			0.0%			0.0%
1-4			0.0			0.0			0.0
5-14	0.0	0.0	0.0	0.0	1.7	1.0	0.0	0.7	0.4
15-44	6.7	6.3	6.4	21.1	6.4	10.2	11.5	5.9	7.4
45+	5.3	17.3	12.2	19.0	19.2	19.1	10.5	18.4	15.0
TOTAL			4.4%			7.2%			5.5

Table 9. Dahomey
Assessment Results

A. Population Examined

Age	Number Examined Male	Female	Total	Age Distribution of Examined Population(%) Male	Female	Total	Age Distribution of Population of West Africa(%) Male	Female	Total
1			69			5.9%			4.3%
1-4	111	131	242	9.5	11.3	20.3			14.5
5-14	100	143	243	8.6	12.3	20.9	13.2	11.9	25.1
15-44	186	306	494	16.0	26.5	42.4	19.7	22.5	42.0
45+	42	74	116	3.6	6.4	10.0	7.4	6.6	14.0
TOTAL			1164			100.0%			99.9%

	Village Population under 500			Village Population 500 - 10,000			Total		

B. Proportion of Persons (age adjusted with History of Jet Injector Vaccination (In Percent)

Age	Male	Female	Total	Male	Female	Total	Male	Female	Total
1			0%			11.1%			8.7%
1-4	73.7	66.7	69.3	67.4	70.3	68.9	68.5	69.5	69.0
5-14	54.6	72.7	76.1	83.9	72.7	77.7	84.0	72.7	77.4
15-44	61.2	59.2	60.0	85.4	75.9	79.4	79.0	72.1	74.7
45+	62.5	75.0	67.9	69.2	62.9	64.8	66.7	64.9	65.5
TOTAL			63.9%			72.4%			70.4%

C. Proportion of persons (age adjusted) with Smallpox Vaccination Scars (In Percent)

1			0%			11.1%			8.7%
1-4	78.9	66.7	71.4	69.6	72.3	71.0	71.2	71.0	71.2
5-14	100.0	75.8	82.6	92.0	80.9	85.8	93.0	79.7	85.2
15-44	79.6	77.5	78.3	92.0	89.0	90.1	88.7	86.4	87.2
45+	81.3	91.7	85.7	84.6	77.4	79.5	83.3	79.7	8.0
TOTAL			76.0%			81.3%			80.0%

D. Proportion of persons (age adjusted) with Scars of Smallpox

1			0%			1.9%			1.4%
1-4	0	10.0	8.2	0	0	0	0	0.8	0.4
5-14	0	12.1	8.7	5.8	4.8	5.2	5.1	6.5	5.9
15-44	16.3	18.3	17.5	15.5	7.4	10.3	15.7	9.9	12.1
45+	25.0	0	14.3	0	13.0	9.8	7.9	11.1	10.0
TOTAL			12.7%			7.1%			8.1%

Table 10. Togo
Assessment Results

A. Population Examined

Age	Number Examined			Age Distribution of Examined Population(%)			Age Distribution of Population of West Africa(%)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1			57			4.9%			4.3%
1-4			266			22.9			14.5
5-14	131	134	265	11.3	11.5	22.8	13.2	11.9	25.1
15-44	143	312	455	12.3	26.9	39.2	19.7	22.5	42.0
45+	50	69	119	4.3	5.9	10.2	7.4	6.6	14.0
TOTAL			1162			100.0%			99.9%

Village Population under 500	Village Population 500 - 10,000	Total

B. Proportion of Persons (age adjusted) with History of Jet Injector Vaccination (In Percent)

Age	Male	Female	Total	Male	Female	Total	Male	Female	Total
1			16.0%			43.8%			31.6%
1-4			70.6			79.6			75.6
5-14	74.3	85.7	81.3	96.9	88.5	93.1	90.8	87.3	89.1
15-44	62.5	79.7	75.0	87.4	83.2	84.6	79.0	81.7	80.3
45+	94.7	70.0	79.6	77.4	84.6	81.4	84.0	78.3	80.7
TOTAL			74.0%			83.7%			79.7%

C. Proportion of persons (age adjusted) with Smallpox Vaccination Scars (In Percent)

1			16.0%			50.0%			35.1%
1-4			73.1			81.6			77.8
5-14	74.3	87.5	82.4	96.9	89.7	93.7	90.0	88.8	89.8
15-44	91.7	89.8	90.3	97.9	95.7	96.4	95.0	93.3	94.1
45+	100.0	90.0	93.9	96.8	92.3	94.3	98.0	91.3	94.0
TOTAL			83.0%			91.2			88.0%

D. Proportion of persons (age adjusted) with Scars of Smallpox

1			0%			0%			0%
1-4			0			0			0
5-14	0	1.8	1.1	0	6.5	2.7	0	4.2	2.1
15-44	8.3	0.8	2.8	6.0	1.3	2.9	6.8	1.0	2.9
45+	5.3	10.0	8.2	14.3	6.3	10.0	10.7	8.1	9.2
TOTAL			2.6%			3.3%			3.0%

Table 11

Contribution of Each Age Group to Total Smallpox Susceptible Pool
(Combined Results from Northern Nigeria, Western Nigeria, Niger, Dahomey and Togo)[a]

Age	A Age Distribution of Population of West Africa[b] (%)	B Percent Susceptible to Smallpox	C Contribution of each Age Group to Total Susceptible Pool $\left(\frac{A \times B}{A \times B} \times 100\right)$
1	4.3	65.3	14.1
1-4	14.5	24.8	18.1
5-14	25.1	10.5	13.1
15-44	42.0	17.0	35.7
45+	14.0	27.4	19.1
TOTAL	99.9	-	100.1

a) The combined results were obtained by weighting the results from each area by its population, as estimated for July 1969, according to the following figures:

Area	Estimated Population July 1969	Percentage of Total Population of Area
Sokoto and Katsina Provinces	6.8×10^6	26.3
Western Nigeria	$10.9 \times$ "	42.1
Niger	$3.8 \times$ "	14.7
Dahomey	$2.6 \times$ "	10.0
Togo	$1.8 \times$ "	6.9
Total	25.9×10^6	100.0

b) United Nations Demographic Yearbook, 1965

Table 12

Estimated Sample Size Required using a Cluster Sampling Technique

Age	Sample Size Needed Without Clustering c/	Clustering Coefficient b/	Sample Size Needed With Clustering (Col. 1-2)	Estimated Number of Persons Obtained from Total Sample of 999a/
0-4	96	1.85	178	188
5-14	96	2.03	195	251
15-44	96	1.51 (Age 15-39)	145	420
45+	96	Not given	145(?)	140
TOTAL	384		663	999

a/ Derived from formula $n = \frac{t^2}{d^2} pq$ See text for definitions and values of symbols.

b/ Serfling, R.E. and Sherman, I.L. - Attribute Sampling Methods USPHS Publication No. 1230, (1965). pg 144.

c/ Derived from age distribution of population of West Africa, United Nations Demographic Yearbook, 1965.

APPENDIX I - SAMPLE SURVEY METHODOLOGY

I. Sample Size

In the assessment surveys, information was desired for each of the following age groups: 0-4, 5-14, 15-44 and 45+. It was decided that the data obtained should be accurate to within ± 10%, except for a 1 in 20 chance. Sample size was determined by using the formula:

$n = \frac{t^2 pq}{d^2}$ where 'p' represents the proportion of the target population having been immunized, and 'q' is 1.00 minus 'p'. The value for 'n', the number of persons required in the sample, is maximized when the value of 0.50 (50% vaccination coverage) is given to 'p'. 'd', the accuracy, has a value of 10%, and 't' has a value of 1.96, indicating a chance of 1 in 20 that the sample was non-representative of the population being surveyed. In solving this formula for 'n' ($n = \frac{3.84\ (0.50)\ (0.50)}{0.0100} = \frac{0.9600}{0.0100} = 96.00$) 96 persons are shown to be needed in each of the age groups about which information is desired.

A cluster sampling method was decided upon, since it is known that the vaccination status of one member of a cluster is likely to be related to the vaccination status of other members of that cluster, the sample size determined above needed to be increased to correct for clustering. From immunization surveys in the United States, Serfling[1] has estimated that the correction factor for clustering for smallpox vaccination is 1.85 in 1-4 year olds, 2.03 in 5-14 year olds, and 1.51 in 15-39 year olds. These clustering co-efficients pertain to members of a single family. No estimates are currently available for West Africa. Lacking this information, Serfling's estimates were applied (Table 12).

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[1] Serfling, R.E. and Sherman, I.L., Attribute Sampling Methods, USPHS Publication No. 1230 (1965), pp 144

With these assumptions, a survey designed to sample a total of 1,000 persons should include a sufficient number in each age group (with the possible exception of the 45+ age group), to provide results accurate to within ± 10%, except for a 1 in 20 chance. This size of sample also provides a large enough number in the 15-44 year old age groups to permit males and females to be analyzed separately.

The same formula which had been used for determining sample size was used to determine the number of clusters needed. For this determination, vaccination coverage was estimated to be 80% and no correction for clustering was necessary. The formula is thus: $n = \frac{t^2 pq}{d^2} = \frac{3.84(0.80)\ (0.20)}{0.0100} = 61.4$

To provide a margin of error, 67 sites were selected in each area and the assessors were asked to examine a cluster of 16 persons at each site. If all sites were completed, this would provide a total sample population of 1,072 persons.

II. Selection of Villages from which to draw Clusters

A list of villages located in areas vaccinated by the programme was obtained for each of the surveys. A list was constructed which contained in three columns the name of each village, its population, and a cumulative total of population for this village and all villages preceding it on the list. A "sampling interval" was obtained by dividing the total population of these villages by 67 the number of sample sites desired. A number between one and the "sampling interval" number was chosen from a random number table, and this served as the starting point. The village whose cumulative population total spanned this number became the first sample site chosen. The "sampling interval" number was added to that determined from the random number table and a second village was selected, and so on until 67 sites were selected.

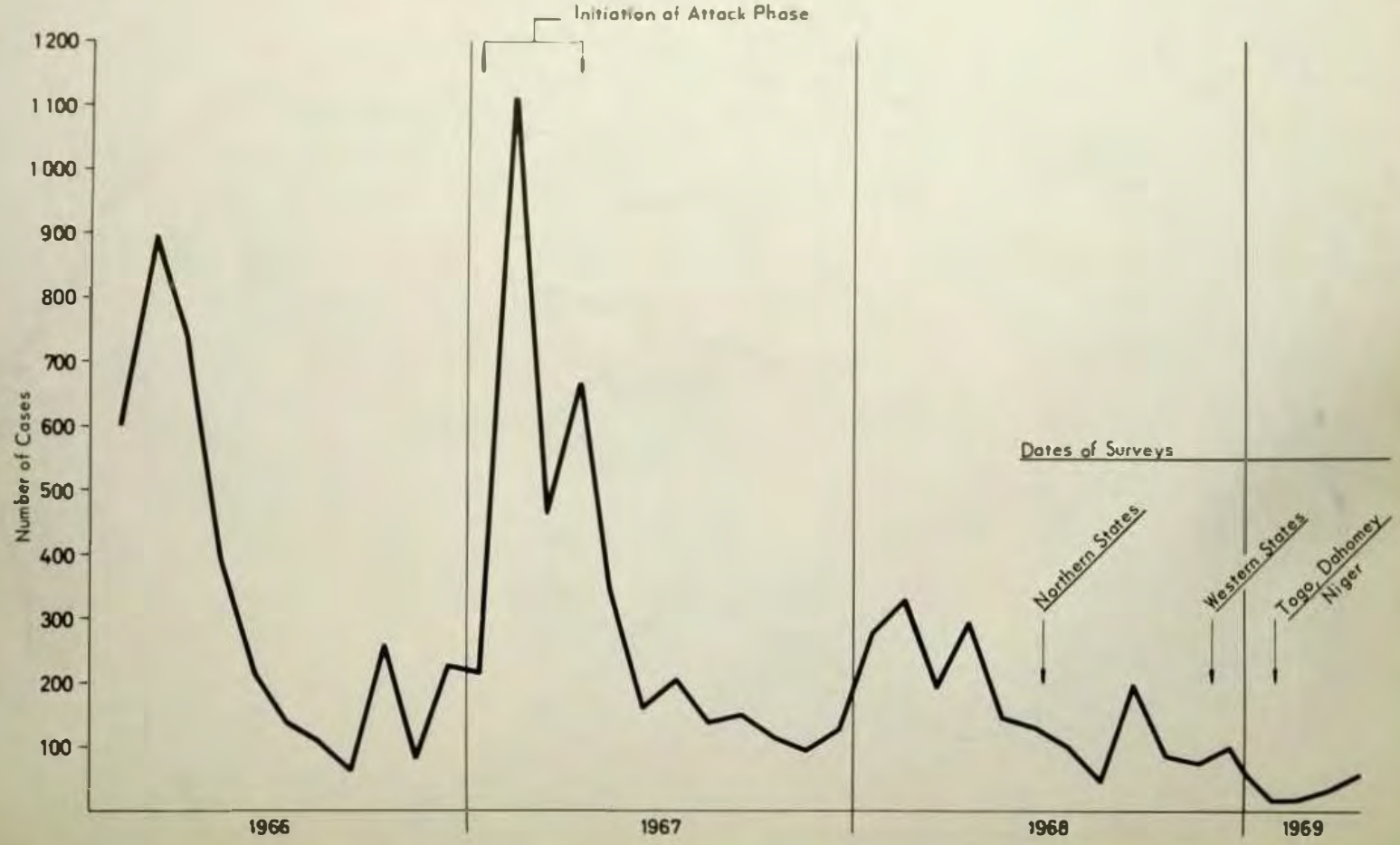
It was recognized that the list of villages which had been obtained was very likely to be incomplete, and every effort was made to assure that all habitations in vaccinated areas would have an opportunity of being sampled. At each of the 67 selected villages, the assessors were instructed to make as complete a list as possible of all habitations usually grouped in small hamlets which fell under the authority of the village and the population of each. This information was ordinarily obtained without difficulty from the village authorities. A list like that previously constructed was then prepared showing hamlet population and cumulative population. The area from which the cluster of 16 persons was to be selected was chosen by using a random number table as previously described. This method gave each area on the list a chance for being selected which was proportional to its population. This procedure was not used in Dahomey and Togo, where the village initially selected from the total list of villages was the one from which the cluster was drawn.

III. Selection of the Cluster

The assessors were instructed to go to the centre of the area selected, i.e. one of the 67 villages initially selected or one of the hamlets or habitations nearby. Each assessor was provided with a paper on which was drawn a circle, marked at 30 degree intervals from 0 through 360 degrees. The assessor oriented himself by pointing the zero degree reading towards the east, a direction which could always be determined by asking the inhabitants, if the sun were overhead or not visible. Using this paper "orientation compass", the direction of a "cluster line" was established by drawing a number between 0 and 360 from a random number table. The assessor then walked in the direction of this line to the edge of the village, counting the number of dwellings which it intersected. A random number table was again used to select one dwelling from the total number counted. The assessor interviewed and examined all persons present who had spent the previous night in this dwelling, attempted to summon any absentees. If less than 16 persons were present, he continued walking in the direction of the line away from the centre of the village and examined the occupants of the remaining dwellings encountered. If the cluster had not been completed by the time he had reached che edge of the village, he moved clockwise from the line to the next dwelling and continued to sample, establishing a new line back towards the centre of the village.

FIGURE 1
AREAS ASSESSED IN WESTERN AFRICA

FIGURE 2
TOTAL REPORTED CASES OF SMALLPOX IN SOKOTO AND KATSINA PROVINCES (NORTHERN NIGERIA), WESTERN NIGERIA, NIGER, DAHOMEY, AND TOGO, BY MONTH
JANUARY 1966-APRIL 1969



SUMMARY CONCURRENT ASSESSMENT

J. D. Millar[1]

Three basic types of assessment have been discussed: 1) concurrent - including both collection of tally data and periodic sampling to determine coverage, 2) "spot checks" or informal appraisals of vaccination coverage, and 3) "terminal" assessment.

Of the forms of concurrent assessment discussed, each is useful and can be complementary to the others. If means are available to the country to pursue all forms, all should be done. The existence of a formal concurrent assessment team, operating continuously, can be bolstered by using "spot-checking" as a supervisory tool to stimulate the assessors and to assure that their job is being done adequately.

I would like to summarize the fundamental objectives of assessment as they have appeared in discussion:

1) To determine if the population is being reached

2) To determine if those reached are being immunized. The determination of "take rates" is especially critical among those who are non-immunes, i.e., primary vaccinees

3) To determine, if the population is not being reached or is not being immunized, why this is so.

4) To initiate corrective action based on the findings. As was said by Dr. Ralph Henderson, the collection of data means nothing without analysis followed by corrective action based on the interpretation. Corrective action has been illustrated by:

   a) immediate action to correct areas of poor coverage and

   b) alteration of programme operations to avoid repetition of such errors in the future.

We have heard examples of all those. The corrective actions taken have varied:

1. Immediate changes in team questions have been initiated on the basis of spot-check assessment to increase emphasis on younger age groups.

2. In Guinea, a "follow-up" vaccination team has been created to bolster vaccination coverage in those areas where the level of coverage is unacceptable and in addition, the total programme approach was re-designed in Guinea to avoid low coverage in small villages.

3. In the mid-West State of Nigeria, the results of assessment are being considered to revise the estimated target population for maintenance vaccinations to be done six months hence.

I would like to emphasize the inter-relationship between assessment and surveillance. As has been said previously, the elimination of smallpox is the ultimate assessment of programme success. This is very true and I support the concept entirely.

[1]Director, Smallpox Eradication Programme, NCDC, Atlanta, Georgia, USA

However, achieving nil cases depends on a series of specific, sequential events. Concurrent assessment makes it possible to assure the success of each of these sequential steps which in turn assures the success of the programme as a whole.

Assessment and surveillance are inter-related. If cases are occurring in vaccinated areas, an assessment of vaccination coverage must be conducted as part of the basic epidemiological investigation to determine why the outbreak developed. Similarly, where assessments show poor coverage, corrective action should include an intensification of surveillance activities within the area.

Finally, the importance of assessment in maintenance operations should be noted. All that has been said about assessment during attack phase activities is even more true during the maintenance phase. With repeated cycles of vaccination, the expected turnout for periodic immunization will decline. In the maintenance phase, furthermore, the target group is small and selective, principally including young infants. Children in the under one year age group have traditionally been one of the hardest groups to reach with mass vaccination. Since newborns constitute the principal groups of new susceptibles, adequate coverage and 100% "takes" must be assured in this group. The success or failure of maintenance activities in preventing the re-establishment of smallpox depends on the continuing successful vaccination with high levels of coverage. The only way to assure this is through continuing concurrent assessment activities.

Before discussing terminal assessments specifically, I would like to make one point regarding the apparent complexity of field sampling techniques in concurrent assessment. An American author, Herman Wouk, wrote a book entitled "The Caine Mutiny." In it, the cynical protagonist describes to a shipmate his view of US naval operations in World War II: "The US Navy operates on a plan designed by geniuses for execution by idiots!" I do not tell this story in the belief that an analogy may exist within our programme! However, I think it can be said that complexity of design is not necessarily incompatible with practicability of execution. The complexities of survey design can be converted step-wise into relatively simple field operations. Our basic responsibility is to see that each assessor understands the specific demands of the sampling technique. Those of us who have done field surveys can attest to the fact that they are much easier to do in practice than they are to describe verbally.

A terminal assessment is done for several reasons:

1) It represents a single total programme review in which operations, assessment, surveillance, and administration, are placed under scrutiny.

2) It provides at a single point in time an accurate appraisal of current immunity levels throughout the total population.

3) It provides a means of estimating the history of smallpox in the area (by means of the age specific smallpox scar rate).

4) It provides an estimate of the total costs of the programme.

5) It permits each of the above to play a role in future planning.

To better illustrate these points, I should like to summarize the findings to date in the terminal assessments.

1) Overall coverage has been lower than expected in most countries. In only one of the five areas did the terminal assessment reveal an overall coverage of 80% or above. Small villages were generally less well covered than

larger ones for reasons principally of accessibility. However, smallpox scar rates indicated that smallpox appeared to have been as frequent in small villages as in large, indicating that one cannot affort to ignore the coverage levels in smaller villages.

2) The frequency of smallpox scars increases with age, as expected, due to the increased opportunities with age for exposure to smallpox.

3) The most dramatic point to be emphasized by the terminal assessment is the rapid dilution of "immunes" in the population under one year of age. This group must be considered as a moving cohort to which are being added susceptibles in increasing numbers every hour of every day. While "dilution" exists in older age groups by in-migration of unvaccinated persons, this dilution is generally insignificant in comparison with the rapid entry of susceptible children by birth.

The findings of the terminal assessments have very real implications for future plans. Attention is drawn again to newborns as the significant source of new susceptibles. All efforts must be directed to reach this group. The number of new births in West Africa approximates 4% of the total population annually. Therefore, unless specific attention is directed to this group, they could represent as much as 12% of the total population in three years. This is a substantial reservoir to support smallpox transmission.

While monotonous and difficult, the terminal assessments have proved highly revealing of problem areas. I should like to acknowledge the tremendous contributions made by Dr. Ralph Henderson and Mr. Hillard Davis in designing and conducting the terminal assessments. Terminal assessment is arduous and monotonous work, but nothing else can provide this type and amount of information. With a method in hand that has been well tested, all countries can and should conduct terminal assessments at intervals as maintenance activities progress. Maintenance will bring its own problems and terminal assessment can be used as a major means for elucidating and correcting them.

MAINTENANCE PROGRAMMES

Introduction: Principles and Goals of Maintenance Programmes
J. D. Millar

Measles

Measles Control in The Gambia
P. J. N'Dow, R. C. Helmholtz

Urban Measles Control
J. I. Adetosoye

The Measles Control Programme in Dakar, Senegal
M. Seck, R. C. Helmholtz

Maintenance of Measles Control in Kano State, Nigeria
R. B. Arnold

Measles Control in Areas of Low Population Density
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Alternative Approaches to Measles Control Using Fixed Centres
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Smallpox

Smallpox Eradication In Africa: Principles for Action in the Maintenance Phase
G. Binson

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INTRODUCTION - PRINCIPLES AND GOALS OF MAINTENANCE PROGRAMMES

J. D. Millar[1]

Maintenance activities are based on three fundamental principles which must be assured if a country is to remain free of smallpox and to sustain effective control of measles. They are as follows:

1) The accumulation of susceptibles must be prevented by conducting vaccination campaigns aimed at susceptibles, i.e., newborns entering the population since the previous campaign. The timing of maintenance vaccination cycles depends upon a country's policy on measles control:

   a) If the country is intensively pursuing nationwide measles control, then maintenance vaccination cycles probably must be conducted at intervals no greater than yearly in rural as well as urban areas. These time relationships deserve more evaluation in the field before they can be reduced to dogma.

   b) In those countries not so intensively pursuing nationwide measles control, the experience in the Ivory Coast, the OCEAC countries and elsewhere suggests that campaigns conducted at three yearly intervals will be adequate to prevent accumulation of sufficient susceptibles to prevent reestablishment of smallpox transmission.

2) High levels of coverage must be assured in the target age group through performance of concurrent assessment following maintenance campaign activities.

3) Each country must have a functional surveillance system capable of identifying imported smallpox cases and measles outbreaks and capable of rapidly responding to such outbreaks. This is an integral part of maintenance activities.

There are adequate examples now from Ibadan, Bamako, Lagos, Dakar, Douala, Libreville and elsewhere which demonstrate that sufficient susceptibles to permit measles epidemics accrue rapidly. If substantial numbers of susceptibles are not permitted to accumulate, measles control can be a reality. However, before one can seriously discuss maintenance of measles control, we must achieve more effective measles control across broader areas than has been the case to date. As we discuss maintenance immunization activities it is well to bear in mind two points:

1) Mass vaccination in maintenance programmes has one characteristic not present in the initial mass campaigns, i.e., a need for stringent selectivity of the target group. Some pilot maintenance projects have already experienced difficulties in limiting the vaccinees to those in the target age group, i.e., those from six months of age to six months older than the interval since the last campaign. Restricting mass campaigns to such a selected target group may demand the evolution of new techniques of information and propaganda and possibly even changes in the basic concepts of mobile field immunization operations.

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2) While the importance of smallpox outbreak control and maintenance of smallpox eradication is well appreciated, the role of measles outbreak control has yet to be defined adequately. It would appear from limited experience that prompt response to measles outbreaks may, in fact, be fundamental to achieving effective measles control. Because of the high contact transmission rate of measles, explosive outbreaks are the rule and, to be successful, "firefighting" techniques will have to be appropriately rapid.

MEASLES CONTROL IN THE GAMBIA

P. J. N'Dow[1], R. C. Helmholz[2]

INTRODUCTION

The maintenance phase is undoubtedly the most important phase in the endeavor to achieve a complete control of measles in The Gambia. This phase requires more publicity to reach those missed in the attack phase and those qualifying by virtue of age to be protected against measles. It is the phase also in which the public requires more information as to the need to keep the disease at an insignificant level. It is, indeed, the phase in which it becomes difficult to keep up the enthusiasm of the vaccinators in what may now be a monotonous or repetitive exercise. In short, it is the pbase that has come to stay!

During the attack phase of the Gambian Smallpox Eradication/Measles Control Programme, 81,000 measles vaccinations were given. The entire country was covered by three mobile teams in just under one year. During the attack phase, teams were not directed to undertake measles outbreak control activities and measles cases were not individually investigated. At the end of the campaign, measles was practically eliminated in our essentially rural country by vaccinating an estimated 92% of the total population between 6 months and 6 years of age. The average number of measles cases reported per year during the 12 year period preceding the campaign was 2,000 (Table 1). Following the campaign, only 43 cases have been reported (Tables 1, 2). Thus, because of the initial success of our attack phase, we decided to continue the cycling of two teams through the country, administering smallpox vaccinations by Ped-O-Jet to all persons not previously vaccinated and measles vaccine to all persons below 6 years of age who had not been previously vaccinated or not previously infected with measles. Measles susceptibility is determined by questioning the prospective vaccinee or his mother. Undoubtedly our pre-vaccination questioning process allows some immunes to be vaccinated, but we felt that this was preferable to permitting susceptibles to go unvaccinated.

Essentially, the method of team operation is the same as that used during the attack phase. One hundred dose smallpox vials are used as well as both 50 and 10 dose measles vials. Teams move on a village-by-village basis, operating out of a semi-fixed base of operations. The teams return to the same base each evening, changing their base about every two to four weeks. The age grouping of vaccinations given suggests that 66% of our measles vaccinations are administered to those coming into the population as a result of birth, and 33% are administered to older children who are immigrants to the area or were missed during the attack phase.

No formal assessment is conducted as we continue to rely on morbidity reports as a gauge of programme effectiveness.

An important aspect of our maintenance programme is the immediate investigation of reported measles cases in order to verify diagnosis, to confirm the vaccination and age status of the case, and to make a judgment as to whether the diversion of the vaccination teams is indicated. To date, no measles epidemics have occurred requiring such a diversion, and no cases have been reported among vaccinated children.

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In the city of Bathurst (population 33,000), not knowing exactly when a city is large enough to necessitate 6 monthly measles vaccination cycles, we decided to vaccinate newborns every 6 to 8 months. The first maintenance cycle in Bathurst was conducted 8 months after the completion of the attack phase. During this interval, 3 cases of measles had occurred. The second maintenance cycle was carried out 6 months after the preceding one. During this interval 2 cases of measles had occurred. Since the last maintenance cycle, 5 months have lapsed and no cases have been reported. Thus, with the level of coverage of 90% in the 6 month to 6 year age group and vaccination cycles every 6 to 8 months in Bathurst, we have, as far as we know, completely interrupted the transmission of indigenous measles cases.

Our high level of coverage was obtained by a very individualized approach. The teams station themselves at every other intersection and send messengers into each compound to look for unvaccinated children, particularly infants. The mothers are then asked to bring the children immediately to the team for vaccination. Another method has been for the teams to cruise the streets slowly with a loudspeaker. When the people bring the children out of their compounds the truck stops and the children are vaccinated. Thus extensive publicity with the use of loudspeakers and the almost immediate accessibility of the teams have been major factors in the success of our Bathurst campaign.

Two other features of our maintenance programme which may be of interest are as follows:

1. We attempt to rotate our personnel including Health Inspector trainees, who are on duty with the vaccination project. We feel that this provides a more balanced workload for our personnel and results in better morale.

2. The local traditional authority structure, such as district and village chiefs, are relied upon heavily in the advance publicity scheme. These men are then thanked formally in a letter from the Medical Officer of Health. We feel that this procedure, continued from the attack phase, has done much to contribute to the continued excellent cooperation obtained from local authority figures and the villagers themselves.

Thus, in summary, the maintenance of measles control in The Gambia is viewed as a practical possibility because we are permitted to recycle often enough to keep the size of the susceptible group below the epidemic threshold. We intend to continue in this manner with mobile teams simply because our static health facilities do not reach a large enough segment of the population to provide the necessary coverage. The characteristic features of the programme are as follows:

1. Mobile teams are cycled each 12-18 months on a village by village basis, with each team averaging about 5 villages per day.

2. Trained personnel at the Dresser Dispenser and Health Inspector levels are used on a rotational basis.

3. Semi-fixed bases of operation are employed.

4. The traditional authority structure is used so that every village is directly forewarned of the pending arrival of a team.

5. Morbidity reports are investigated and teams would be re-routed if an epidemic were encountered.

6. Vaccination certificates are not routinely used.

7. The teams work year round by scheduling more easily accessible areas for coverage during the rainy season.

CONCLUSION

The Gambian Government has agreed to provide the support for financing this phase which is estimated to cost 25% less than the attack phase. It is, therefore, logical to expect the Government to make provisions annually for the maintenance of measles control as part of the Social Services provided for the country as a whole, when U.S. assistance ceases to provide vaccines and equipment.

A brief note should be made on inter-territorial cooperation. This affects our relationship with neighbouring Senegal. Happily, they are well ahead in their attack phase. Thus it remains for us to harmonize our control measures. It is of interest to note that we have signed agreements to exchange epidemiological data and coordinate our preventive measures in the control of endemic diseases prevalent in our two countries. For the implementation of agreed policies, there is based in Bathurst a Senegal-Gambian Secretariat, which coordinates the work of the Inter-Ministerial Committees of the two countries.

Undoubtedly, this short note on the maintenance of measles control in The Gambia will be considered incomplete without reference to surveillance. In our surveillance system, there are obvious difficulties which are likely to be overcome in due course. At the present time, since we have not achieved a full medical coverage by the provision of Basic Health Centres with professional or trained staff, a large proportion of measles cases are never seen by our trained staff. Statistical recording is improving gradually, but there are still difficulties in the presentation of data.

TABLE 1

Measles Reports by Year in The Gambia, 1957 to 1969

YEAR	CASES	DEATHS
1957	848	72
1958	10	-
1959	1,307	48
1960	690	49
1961	1,526	29
1962	2,044	55
1963	5,113	146
1964	803	9
1965	1,297	16
1966	1,961	48
1967	4,150	51
1968	192	0
1969*	6	0

*Up to 22 March

TABLE 2

Reported Measles by 4-Week Periods
and Geographic Areas
The Gambia
1967 -1968

	Week	Total	Western Division	Bathurst	Lower River Division	Upper River Division	North Bank Div.	McCarthy Island Division
1967	1-4	184	75	75	2	3		67
	5-8	247	87	73	14	19		54
	9-12	509	208	106	42	17		136
	13-16	699	443	101	47	2		204
	17-20	721	435	94	85	8		68
	21-24	777	389*	113	184	11		30
	25-28	472	247*	65	126	1		33
	29-32	390	173*	55*	84	3		15
	33-36	63	7	8*	36*	1		11
	37-40	137	2	2	100*	-		33
	41-44	20	-	-	11*	-		9
	45-48	2	-	-	2*	-		-
	49-52	7	1	-	1*	-*		5
1968	1-5	49	2	-	-	4*		43
	6-9	61	-	-	-	5*		56*
	10-13	30	-	-	-	-		30*
	14-17	14	-	-*	-	-		14*
	18-22	6	1	-*	-	-		5
	23-26	6	4	1	-	-		1
	27-31	6	5	-	-	-		1
	32-35	3	3	-	-	-		-
	36-39	4	-	-	4	-		-
	40-44	13	2	1	3	-		7
	45-48	-	-	-	-	-		-
	49-52	-	-	-	-*	-		-
1969	1-5	1	-	-	-*	-	1	-
	6-9	2	1	-	-*	-	1	-

*Measles vaccinations performed during period.

URBAN MEASLES CONTROL

J. I. Adetosoye[1]

INTRODUCTION

This paper deals with our experience in the control of measles at Ibadan from July 1967, when a mass measles vaccination campaign began, up to the present time. It is appropriate that such a review be made, as the planning of all urban measles campaigns in the Western State was based on the Ibadan experience. Also any solution to the present set-back in measles control in the city may be found useful in the future measles maintenance campaigns in Western Nigeria.

BACKGROUND

The city of Ibadan is the largest in West Africa, and is the main centre for trade, education and administration in the Western State of Nigeria. The population of the city has been estimated to be between 700,000 to 1,000,000. In the 1963 census the population was 627,379. There are innumerable villages and hamlets within a few miles of the city which are related to it both socially and economically. There is a continuous population movement between the villages and the city, and many people take up temporary residence in the city or in one of the surrounding villages for varying periods of time.

All hospitals in the city report infectious disease cases weekly to the Health Authority, but it is believed that such notification of measles represents only a small percentage of the number of cases actually occurring in the city.

MEASLES AT IBADAN AND MEASLES CONTROL PROGRAMME

Measles is endemic throughout the year, but shows a marked seasonal variation, with an increased incidence in the months of November to March (Figure 1).

The Western State launched the attack phase of the Smallpox Eradication and Measles Control Programme at Ibadan in July 1967. Due to excellent publicity and organization, public support of the campaign was very good and in a period of fifteen days, 73,227 measles vaccinations were administered to children between the ages of six months through 3 years (Table 1). A post-campaign assessment revealed a coverage of 92.6% in this age group. The campaign had a dramatic effect on measles incidence as shown by the low level of the disease in the city (Figure 1).

In February 1968, the first measles maintenance campaign took place and a total of 6,392 children were immunized. This campaign failed in the coverage of children susceptible to measles, as it was estimated that there were about 35,000 non-immune children at the beginning of the campaign. However, the measles incidence in the city remained at a low level for another four months. A better maintenance campaign was carried out in July 1968 and during a three-week period, a total of 34,301 children were immunized against measles.

At the completion of the campaign, it was believed that a satisfactory coverage of the non-immunes had been achieved. We estimated that the number of children at risk had by then been reduced to 3,000.

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[1]Medical Director, SPE/MC Programme, Ibadan, Nigeria

IBADAN MEASLES EPIDEMIC AND EPIDEMIOLOGICAL INVESTIGATION

Beginning in November 1968, an unusually large number of measles cases were reported at Ibadan. This fact, coupled with the observation that many cases of measles were being noted in vaccinees, gave rise to concern. Investigations were carried out throughout the epidemic in an effort to clarify the situation. Data on age, sex, history of measles vaccination and the date of vaccination were obtained on measles patients attending the hospitals in the city. Among 1,063 measles patients, 14.4% gave a history of previous measles immunization, while in 85.6% no such history was obtained. The ages of 77 vaccinees at the time of their vaccinations were available, and it was found that 46.8% of them were given measles vaccine between the ages of four months to nine months, a period during which maternal antibodies might still interfere with active immunity. The remaining 53.2% had measles vaccine at the ages of ten months and above, and this would suggest operational failure.

The age group distribution of cases is shown in Table 2. It may be noted that 77% of cases occurred in children up to the age of two years. The age group distribution of measles cases occurring during the interval between the mass campaign and the epidemic is shown in Table 3. Between August 1967 and January 1968, 10.5% of measles cases occurred in children 12 to 24 months of age; while in the months of March to June 1968, 29.4% of the cases occurred in this age group and from August 1968 to January 1969, 39% of measles cases occurred in this age group. This finding would suggest a diminishing coverage of the target population (children between 6 to 11 months old), during the February and July measles maintenance campaigns.

More cases were recorded among males than females in the epidemic (Table 4). While the overall rate for the city was 1.6 per 1,000, certain wards had much higher rates than others. Higher rates generally were observed among the less enlightened.

A measles campaign was started on 13 January 1969 after adequate publicity and propaganda. The weekly cumulative vaccinations performed compared to the weekly measles notifications are shown in Figure 2. A decline in cases notified occurred when the cumulative vaccinations reached 40,000.

DISCUSSION AND CONCLUSION

Measles for the first time since the campaign of July 1967 came back in epidemic form after a relatively low level of incidence. It was established that the epidemic occurred mainly in unvaccinated children and to a less extent in vaccinees. There is a need, however, for further observation in order to determine to what extent measles is occurring in vaccinees. It is difficult to understand why an outbreak of such magnitude should occur shortly after the 1968 July measles maintenance campaign, as it was believed that the number of non-immune children after the campaign was small. Measures to control the outbreak, have so far not been completely successful. It is postulated that the influx of people into the city from the nearby villages and hamlets which started in November in preparation for the Christmas and Moslem festivals created in the city a large pool of susceptible children. However, there was no such epidemic in the same period in 1967 when a similar population movement would have been in progress, and there is no evidence to suggest that the movement was on a larger scale in 1968 than in the previous years.

An alternative suggestion is that we have underestimated the number of children at risk. This is quite possible since the vital events of birth and death are not officially registered, and no estimate of population turnover is available. As it may be in the distant future before such events are recorded, it would be important to determine the level of measles immunity at the end of each maintenance campaign on a random sampling basis.

TABLE 1

Numbers Vaccinated During Measles Campaigns - Ibadan

Age	July 1967	February 1968	July 1968
6 mos. - 1 yr.	12,183	2,949	4,980
1 - 3 yrs.	61,044	3,443	29,321
TOTAL	73,227	6,392	34,301

TABLE 2

Age Distribution of Measles Cases Notified During Measles Epidemic, November 1968-April 1969

Age Group	No. of Cases	Percentage	Cumulative Percentage
Under 1 yr.	952	36.5	36.5
1	1,057	40.5	77.0
2	311	11.9	88.9
3	124	4.7	93.6
4	63	2.4	96.0
5	34	1.3	97.3
Over 5	71	2.7	100.0
Unknown	115		
TOTAL	2,612		

TABLE 3

Age Distribution of Cases Between the Mass Campaign and the Epidemic in Percent

Age	Aug.1967-Jan.1968 (19 cases)	Mar.1968-June 1968 (34 cases)	Aug.1968-Dec.1968 (934 cases)
Under 1 yr.	15.8	26.5	37.3
1	10.5	29.5	41.2
2	36.8	14.7	10.2
3	15.8	17.6	4.7
4	21.1	2.9	2.4
5	-	2.9	2.0
Over 5	-	5.9	2.2
	100.0	100.0	100.0

TABLE 4

Sex Distribution of Measles Cases Ibadan
(Health Office Data Only)

Month	Male	Female
November	24	19
December	121	93
January	201	171
February	139	129
March	241	203
April	41	32
TOTAL	767	647
PERCENTAGE	54.2	45.8

FIGURE 1
MEASLES NOTIFICATIONS BY 4 WEEK PERIODS
IBADAN – 1963-1969

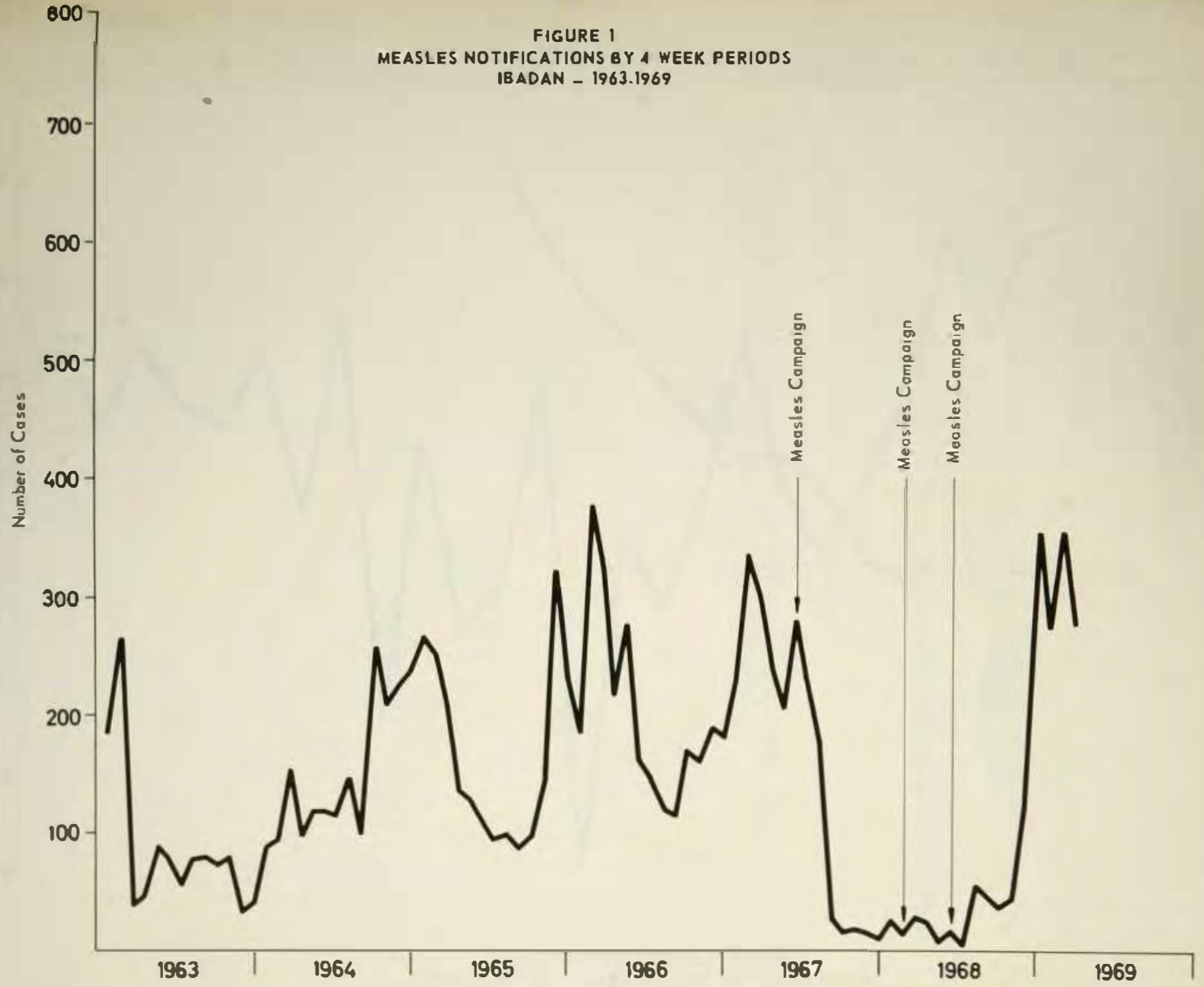

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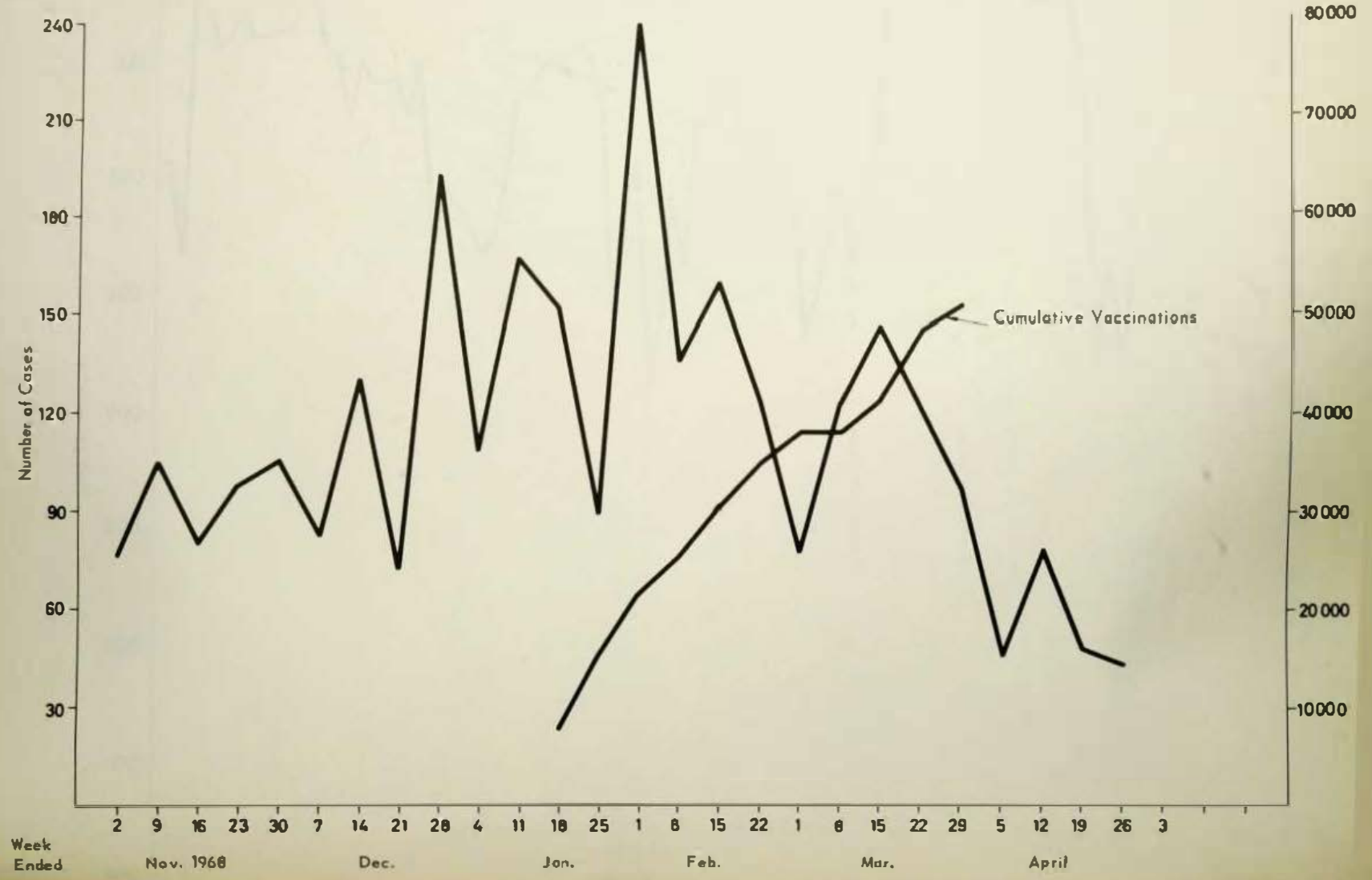
FIGURE 2
WEEKLY MEASLES NOTIFICATION AND CUMULATIVE MEASLES VACCINATION – IBADAN



THE MEASLES CONTROL PROGRAMME IN DAKAR, SENEGAL

M. Seck[1] & R. C. Helmholz[2]

The measles vaccination campaign in Dakar was made up of three successive operations. During the first, which lasted from September 1967 to the middle of January 1968, 63,500 children of 84,600 (75%) between the ages of six months and four years were vaccinated. Two months later, a sample survey in a suburb with a high population turnover showed a coverage of 71% for this group. Eight months after the campaign, another sample survey was conducted which showed a coverage of 40% to 60% in the same group. The success of the first mass vaccination programme was attributed to the use of all medical posts as assembly points and vaccination centres and good publicity provided by the radio, the press and by lorries equipped with loudspeakers.

The second operation was begun six months after the end of the first and lasted 2-1/2 months. The number of vaccinations performed was 35,600. Vaccine was given to all children who were said not to have been vaccinated before and had not experienced measles. Coverage was estimated to be about 90%. This improvement in coverage was attributed to the provision of an increased number of vaccination centres, some of which were outside the medical centres. Initially three vaccination teams were employed but later only two. Publicity by radio was increased with announcements being made every day. The lorries equipped with loudspeakers were not used.

The third operation was begun on 1 April 1969, six months after the end of the second. Between 10,000 and 15,000 children will be vaccinated. The same media as before are being used to publicize the campaign (radio, posters, newspapers).

EFFECT OF THE CAMPAIGNS ON MEASLES MORBIDITY

A comparison of morbidity data at one centre in Dakar, Caisse de Compensation, for a 10 month period before and after the first operation shows a 58% decrease in cases seen. Five weeks after the beginning of the first campaign, the monthly incidence of measles fell to, and remained for eight months at, a level of 70-75% below the monthly levels observed before the vaccination campaign. The most striking decrease in morbidity occurred a full month after the inauguration of the campaign but persisted for six months only.

The second campaign began about ten months after the beginning of the first. A retrospective assessment showed that the second campaign had begun two months after the monthly incidence of measles cases had increased to the same levels observed before the first campaign. A sharp decrease in the number of measles cases again occurred about one month after the beginning of the second campaign.

The third campaign began, on 1 April 1969, 8-1/2 months after the beginning of the second operation, 6 months after it was concluded. Investigations have now shown that the third campaign was begun two months too late as measles incidence had already begun to increase.

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[1]Directeur du Service des Grandes Endemies, Dakar

[2]Operations Officer, Senegal Adviser, NCDC/USAID, Dakar

A total of 194 cases believed to have occurred among vaccinated children were seen at the Caisse de Compensation. Investigation showed that 78% were very probably either cases of measles contracted immediately before or shortly after vaccination, or of post-vaccination reactions. The remaining 22% (41 cases) were presumably due to unsuccessful vaccination. Compared to the total number of vaccinated children, this figure is considered to be insignificant.

DISCUSSION

As far as maintenance of effective measles control in Dakar is concerned, we have observed that:

(1) The campaigns must be carried out in such a way that the period between the commencement of each successive campaign does not exceed six months;

(2) Despite vaccination of more than 100,000 of 130,000 children between the ages of 6 months and 4 years over a period of 20 months, we have not achieved a decrease of more than about 50 to 60% in the monthly measles morbidity. We feel that it is necessary to evaluate the coverage more precisely and to relate the levels of coverage achieved by the campaigns to their frequency;

(3) With only three vaccination teams, a reduction in the incidence of measles was achieved only after one month following the beginning of each vaccination campaign.

We must either change our method of work so as to achieve more quickly a higher percentage coverage of those at risk, or devise ways to carry out the campaigns at shorter intervals.

MAINTENANCE OF MEASLES CONTROL IN KANO STATE, NIGERIA

R. B. Arnold[1]

INTRODUCTION

In September 1968, a pilot project was established in Kano State, Nigeria, for the "Maintenance" phase of the Smallpox Eradication and Measles Control Programme. This followed the mass campaign which was conducted between April and July 1968. Kano State was chosen for this pilot project because it was the first of the Northern States to have completed the "attack" phase of the programme. In addition, Kano State was considered a focal point in the epidemiology of smallpox in Northern Nigeria.

The population in Kano State is estimated to be 5.7 million, with 0.5 million residing in Kano City itself. Rural Kano State is a heavily populated (133.6 persons per sq. km.), predominantly groundnut growing area. Kano City, which is the biggest city in Northern Nigeria, as well as the commercial and transport centre, has a large transient population. Resident are many non-Hausa traders, travellers and government employees along with many rural workers who come to Kano City at the end of the harvest season to look for work.

MAINTENANCE PROGRAMME

In November 1968, the Kano State Epidemic Control Unit was organized with the stated purpose of "administering both measles and smallpox vaccine to the children entering the population, thus eliminating the prime source of susceptibles". It was decided that the first cycle of maintenance vaccinations would be of the "mass campaign type", i.e. all children between 6 and 12 months would be given measles and smallpox vaccines. In addition, any child up to age 48 months in urban Kano and up to age 36 months in rural Kano would be given measles vaccine if he had not previously received this antigen. All persons of any age who had not received smallpox vaccine in the recent mass campaign would also be vaccinated. This approach was felt to be necessary for the first maintenance cycle to increase overall immunity to smallpox to a more acceptable 90% level. Further, although there had been no major outbreaks of measles in the city since the mass campaign, in some porrions of the city, coverages of only 35% to 68% had been recorded in children 6 months to 4 years of age.

Training of five teams of three men each began on 2 December. In an effort to reach the large number of transients as well as the more resistant segments of the population, schools, industries, markets and motor pools were vaccinated between 6 December and 13 January. At this time only smallpox vaccinations were given.

On 14 January 1969, the official maintenance campaign began in Kano City. Through the Local Government Authority, the heads of all wards were notified as to dates, times and places of vaccination. The State Ministry of Information and the Local Government Authority Ministry of Information each provided two sound trucks which were operated daily for two and one-half weeks including four days before the programme started. For 14 nights a film show was presented at different sites with a feature film on smallpox and talks by Kano Commissioners emphasizing that mothers should bring their children for measles vaccinations.

In this first maintenance cylce 27,392 (17.7% of the total vaccinated) between 6 months and 4 years of age received measles vaccinations; 4,892 of these were between 6 and 13 months old. Subsequent assessment showed that the immunity level in the population residing outside the city walls was raised to 89.8%, whereas before the maintenance cycle it was 76.3%. In those 6 to 13 months old, the immunity level rose to 84.6% (Tables 1, 2).

[1]Medical Officer Adviser, NCDC/USAID, Kaduna, Nigeria.

Table 1. Proportion of Persons Vaccinated (in %) - Kano (Outside the City Walls)

Proportion vaccinated in	6-13 mo.	1-3 yrs.	4-14 yrs.	15+ (Male)	15+ (Female)	Total
May 1968	(-80.8-)		84.4	76.7	68.8	76.3
Jan. 1969	76.9	74.3	75.8	56.2	53.4	70.1
Total May-Jan.	84.6	89.8	94.4	85.4	88.4	89.8

Table 2. Proportion of Persons Vaccinated (in %) in Sabon Gari*

Proportion vaccinated in	6-13 mo.	1-3 yrs.	4-14 yrs.	15+ (Male)	15+ (Female)	Total
May 1968	35.7	68.2	51.0	56.0	56.8	58.7
Jan. 1969	56.5	51.8	50.0	50.8	47.4	
Total May-Jan.	69.3	81.2	77.9	79.5	76.9	

* Sabon Gari is a section of Kano City that had the poorest coverage in the mass campaign.

In rural areas, regular efforts were made to educate the District and village heads on the need for immunizing only certain groups (unvaccinated persons and all 6-13 month old children). This was done by a Senior Health Superintendent who visited each district a week before the teams arrived.

Operating with six teams of 3 men each, the maintenance programme completed seven rural districts between 10 February and 15 April. They gave a total of 33,103 measles immunizations. Table 3 lists by district the estimated populations and numbers vaccinated. Assessment has not been completed in any of these districts. However, coverage figures based on population projections appear to be disappointing in most districts.

Table 3. Estimated Coverage in the 6 - 12 Month Target Group

District	1968 Population	Estimated Population 6-11 Months	Number Vaccinated 6-11 Months	Estimated Coverage (%)
Ungogo	99,243	2,084	751	36.0
Kumbotso	95,512	2,006	511	25.4
Kura	227,922	4,786	1,443	30.1
Dwakin Tofa	384,074	8,065	2,418	30.0
Karaye	183,034	3,844	3,025	78.7
Rano	231,492	4,861	2,688	55.3
Tudun Wada	123,740	2,598	1,055	40.6

MEASLES INCIDENCE

The mass campaign was conducted in Kano State from April through July 1968 and achieved a coverage of greater than 90% in the rural areas while Kano City had an overall coverage of 79.5%. In the rural areas, the coverage in the 0-4 year age group was less than 90% and in Kano City the coverage for the same group was 80.8%.

After the mass campaign it was felt that measles in Kano State should decline. Measles normally occurs in epidemic form every other year, but during non-epidemic years there are still a large number of cases (Fig. 1). The increased number of cases that were reported during the years 1966-1968 probably represents more complete reporting. Since the May 1968 mass campaign, Kano has continued to report measles cases. Figure 2 superimposes the graphs for the years 1966-67 and 1968-69. There is little difference in the number of cases reported in the period June 1966-April 1967 and June 1968-April 1969 although this period in both instances represents the seasonal low so that numbers are relatively small. The question arises as to why there has been no difference in measles incidence since the mass campaign. Assessment in Kano State showed that 85.9% of the 0-4 year age group was vaccinated. However, smallpox vaccination coverage in the adult females was only 71.3% and it seems reasonable to assume that the youngest age groups, who were carried on their mothers' backs, may have been vaccinated in the same proportion. Second, measles vaccine may be only 95% effective under field conditions and this small increment of vaccine failures would enlarge the pool of susceptibles to 25% of the children in this age group. Third, there may have been an increase in completeness of reporting after the mass campaign.

On the positive side, it is noted that between January and April, Kano State reported only 4 measles deaths compared to an average of 76 in the January-April period during the previous four years (1965-1968).

CONSIDERATIONS FOR THE FUTURE

1. On the basis of experience to dace in Kano City, it is believed that the maintenance cycles should be aimed at the 6 to 12 month age group only and no vaccinations should be given to anyone older. Every effort should be made to increase the coverage in this age group co 90-95% so that it is not necessary to vaccinate individuals who were missed initially. These cycles should occur at six month intervals until the State's services are so developed that they can be responsible for vaccination on a continuing basis. This should be achieved as soon as possible as the administrative as well as public enthusiasm for periodic "cycles" of mass vaccination is likely to decline.

2. In the rural Districts, immunizations should be given to those who are six months of age plus those who have reached this age since the last maintenance cycle. Until experience indicates otherwise, these cycles should be conducted at twelve month intervals.

3. At least in some States, if the task of fielding permanent maintenance units to administer one or two antigens is prohibitive, it may be necessary to consider the mechanics and costs of adding other antigens.

4. In urban areas, permanent vaccination sites should be established which are clearly marked with a large sign announcing the date and time when these vaccination sites will be used. These signs should be posted at least one month in advance. The same vaccination sites should be used in each cycle so as to form a routine for the mother to have her child vaccinated at this specific site when he is between 6 and 12 months of age.

5. A measles report form should be considered for urban areas to be submitted weekly by the various clinics giving age, sex and address of each case. Cases should be followed up by the maintenance unit.

6. A full-time surveillance and assessment team with its own transport should be established which is capable of rapid follow-up of suspect cases of smallpox and outbreaks of measles. Assessment should be scheduled only once each year in any given area to keep sample sizes at a minimum.

7. The task of training the teams as well as the public in the concept of vaccinating only a specific age group is a long-term project. Efforts to explain to village heads will have to be much more intensive. Establishing a target based on age obviates the troublesome and perhaps unreliable screening for smallpox scars as a mark of having received measles antigen. This type of screening would be a difficult and time consuming task with the large populations of Northern Nigeria.

FIGURE 1
MEASLES CASES REPORTED IN KANO CITY
BY FOUR WEEK PERIODS - 1962-1969

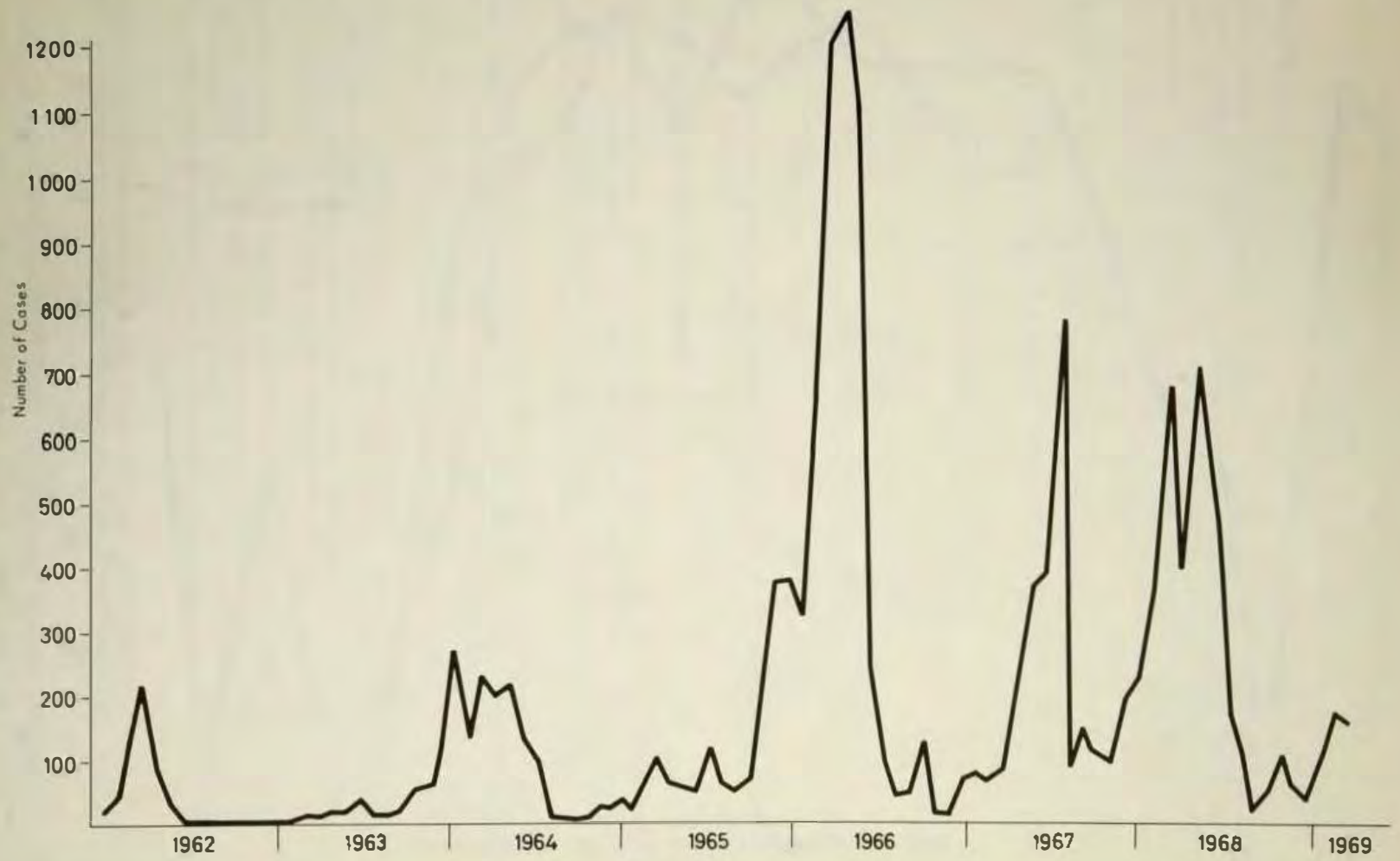
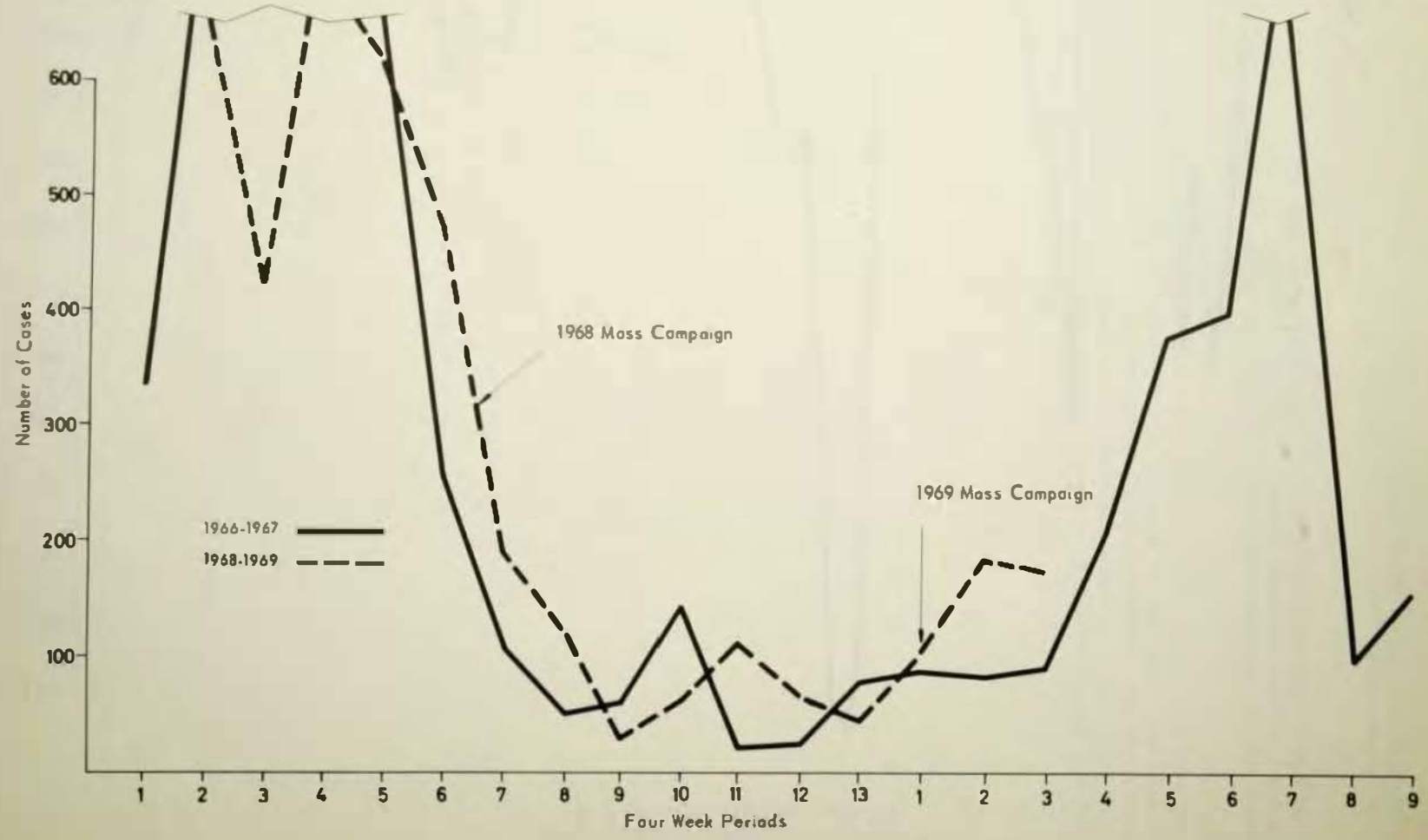


FIGURE 2
COMPARISON OF MEASLES CASES BY FOUR WEEK PERIODS
1966-1967 AND 1968-1969



MEASLES CONTROL IN AREAS OF LOW POPULATION DENSITY

J. C. Gilles[1]

I. INTRODUCTION

Straddling the equator, the Republic of Gabon is 267,000 square kilometres in size and consists almost entirely of equatorial rain forest. In the most recent demographic survey in December 1968, the population was estimated to be 472,097 (density: 1.7 inhabitants per square kilometre) of which 63,000 reside in Libreville and 24,345 in Port-Gentil, the two largest cities. The birth rate is 36/1000 and the death rate 30/1000, giving a yearly population increase of 6/1000.

The distribution of the population by age is shown in Table 1.

Table 1: Distribution of Population by Age

Age	Population	Percent
0-4	58,540	12.4
5-14	83,561	17.7
15-44	222,247	47.5
45+	105,749	22.4
TOTAL	472,097	100.0

The 6 months to 6 year age group is estimated to be 16.5% of the population. The 0 to 20 age group is estimated to be 35.6%.

II. THE EPIDEMIOLOGY OF MEASLES IN GABON

Data from the last ten years (1959-1968) demonstrates that measles is endemic in Gabon (table 2, figure 1) with yearly outbreaks of epidemic proportions. The disease exacts a heavy toll among Gabonese children since the number of deaths attributable to measles each year is between 0.43% and 1.65% of total deaths from all causes.

Overall measles morbidity showed an initial decline in reported cases following the start of the campaign (figs. 1,2). However, in both Livreville and Gabon as a whole sharp epidemics subsequently occurred. A recent rural epidemic in a non-vaccinated sub-prefecture demonstrates that measles eradication is still far from realization in Gabon and that severe outbreaks of epidemic proportions can appear at any time.

The rural areas of Gabon with a lower population density seem to have a lower measles morbidity than urban areas. Thus, although the population of Libreville represents approximately 13% of the population of Gabon, the number of cases reported from the city varies between 19.3% and 26.3% of all cases reported.

Io 1968 a significant change took place in measles morbidity in Gabon as a direct result of the mass measles vaccination campaign which began in 1967. In 1968 there were only 822 reported cases in rural areas. However, an epidemic in Libreville of 1,119 cases raised the proportion of cases occurring in urban areas to 57% of the total.

This epidemic occurred less than 6 months after the mass campaign in the city. In all, 28% of the cases were in children too young to have been vaccinated at the time

[1]Director, Service des Grandes Endemies/Technical Director, Ministry of Public Health, Gabon.

of the campaign, a few cases occurred in vaccinees, and the remainder occurred in children who had not been reached by the maintenance vaccination sessions or who had purposely avoided vaccination for various reasons. A curious fact is that 3.4% of the cases were under 6 months of age (Table 3).

Measles control can only be accomplished by continuing to vaccinate on a scale sufficient to attain a coverage which will provide a high level of immunity. This will require systematic maintenance activities using mobile teams which will reach all children 6 months to three years of age.

Table 2. Measles Cases and Attack Rates Among Children 6 Months to 6 Years of Age in Gabon, 1959–1968

Year	Number of Cases	Attack Rate Among Children 6 Months - 4 Years (%)
1959	2,980	4.0
1960	1,265	1.7
1961	6,112	8.2
1962	3,087	4.1
1963	4,782	6.4
1964	2,243	3.0
1965	3,916	5.3
1966	7,369	9.8
1967	3,073	4.2
1968	1,941	4.9

Table 3. Age and Sex of 761 Measles Cases in Libreville 1968–1969

Age	Cases			
	Male	Female	Total	Percent
0 to 5 months	11	15	26	3.4
7 to 12 months	125	103	228	27.9
1 year	168	141	309	40.6
2 years	56	65	121	15.9
3 years	18	33	51	6.8
4 years	3	5	8	1.0
5 years	6	5	11	1.4
6 years +	4	3	7	0.9
TOTAL	391	370	761	

FIGURE 1
NUMBER OF MEASLES CASES BY MONTH
GABON – 1966-1969 (March)

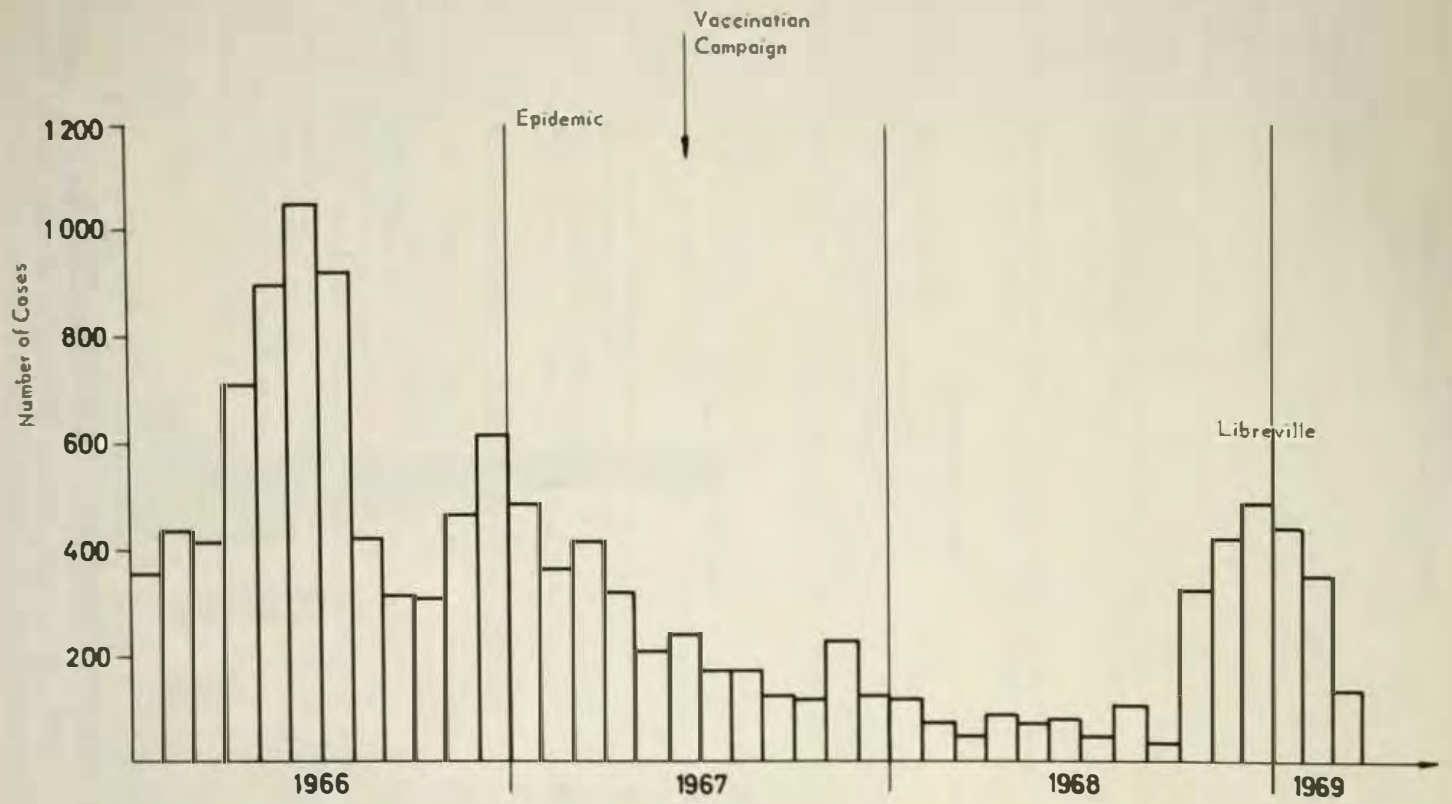
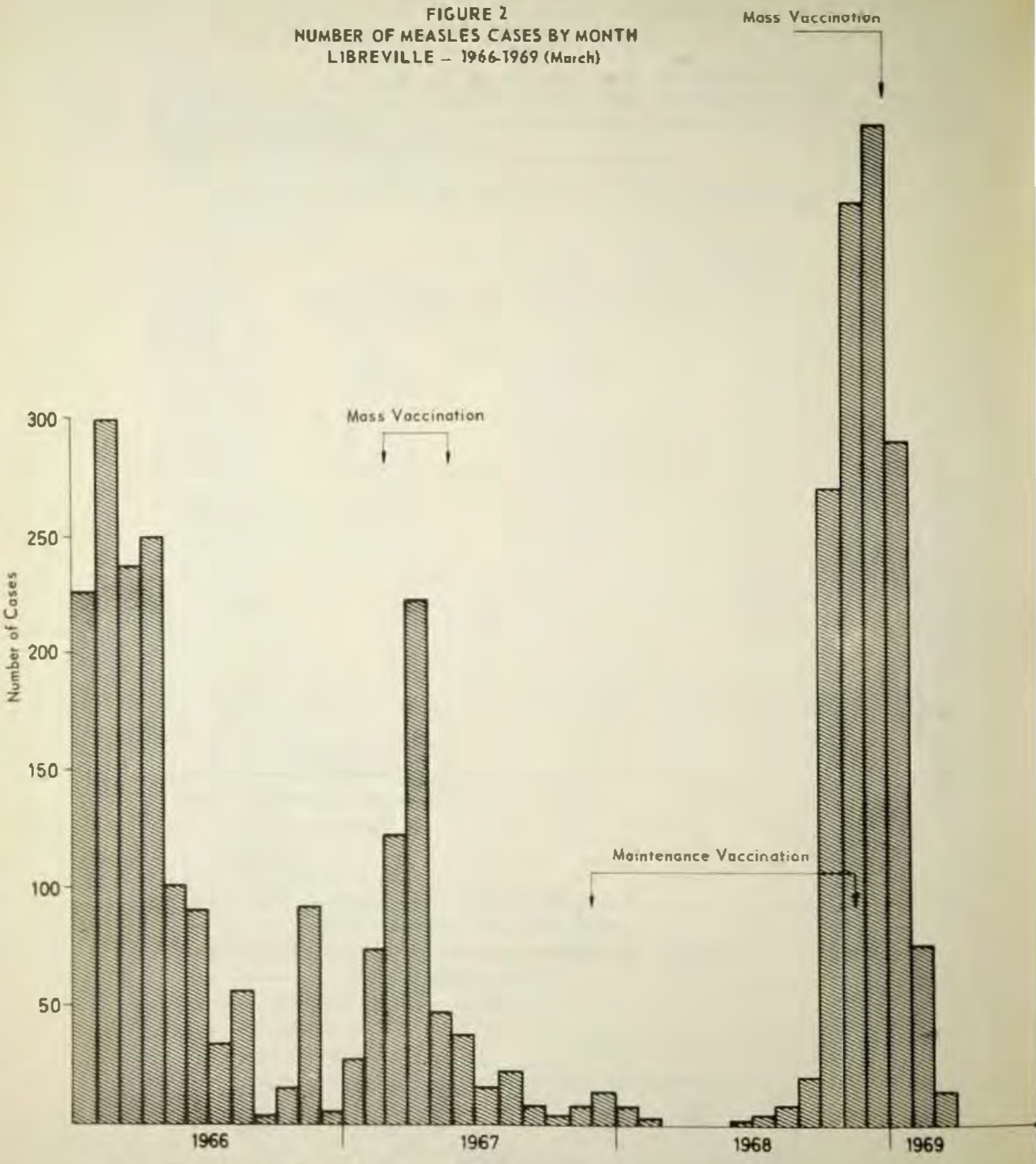


FIGURE 2
NUMBER OF MEASLES CASES BY MONTH
LIBREVILLE – 1966-1969 (March)



Number of Vaccinations: First Mass Vaccination – 11,860
Maintenance Vaccination – 1,002
Second Mass Vaccination – 3,917

ALTERNATIVE APPROACHES TO MEASLES CONTROL USING FIXED CENTRES

D. M. Thompson[1]

INTRODUCTION

Although a national measles reporting system does not yet exist in Liberia, the effect of the attack phase immunization programme in reducing measles morbidity and mortality can clearly be seen. The maintenance programme must attempt to preserve this effect in as efficient a manner as possible within the financial limits imposed.

The old notion, that the maintenance phase for measles control should begin after an entire country had finished its attack phase, has been discarded. The susceptible population increases so fast, particularly in urban and densely populated rural areas, that one cannot wait till the end of the attack phase to begin the maintenance programme.

Since measles maintenance programmes will continue for many years, it is obvious that they must fit into the future health planning of the country. This requires careful planning now!

APPROACHES TO MAINTENANCE OF MEASLES CONTROL

The most effective method for maintenance of measles control would be to immunize each child as he or she enters the age of susceptibility at about 6 months of age. This ideal approach however would be most difficult to put into practice for obvious reasons.

The next best solution would be to attempt to immunize as many children as possible upon entry into the susceptible age with or without a concomitant attempt to immunize the entire susceptible population by means of mass campaigns at certain intervals. This interval might be anything from 1 to 3 years. The efficiency of the programme in reducing measles susceptibles would decrease as the interval between campaigns increased. Dr. Millar in a recent computer study on measles immunization has concluded that a yearly cycle is necessary if measles transmission is to be interrupted. Measles then would cease to be an endemic disease and would occur only as sporadic outbreaks.

LIMITING FACTORS IN THE CONDUCT OF A SUCCESSFUL MEASLES CONTROL PROGRAMME

The demography and geography of a country will limit the possible approaches to measles control. Liberia has a population of approximately 1.1 million distributed over an area of roughly 97,000 km^2, with a population density by country of 3.7 to 38.3 persons per square km. About one-third of the population live in villages of less than 100 persons and the total number of towns and villages is approximately 14,000. Most of these villages cannot be reached by car. The number which would need to be vaccinated annually is only 5% of the total population or about 50,000 children. The problem then is not the number of children that must be immunized, but rather the difficulty and cost of reaching all the villages in which the children live.

THE LIBERIAN MAINTENANCE PROGRAMME

A Ten Year National Health Plan has recently been completed for Liberia. In the plan it is stated:

> "The main objective of the plan is to provide health care for the people of Liberia within the financial resources of the Republic. In doing so,

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[1]Medical Officer Adviser, NCDC/USAID, Monrovia, Liberia.

the primary concern will be to place greater emphasis on the prevention of disease and the promotion of health. In Liberia, the creation of a basic health structure from which services can be operated is essential for the promotion of any health activity. Therefore the first objective should be to provide this basic structure throughout the country, more particularly in the hinterland where the existing services are meagre."

This will be carried out through a system of:

1. Health posts
2. Peripheral Health Units
3. Health Centers at the County Headquarters

The Peripheral Health Unit (PHU) will be responsible for a population of 25,000 to 50,000. Its personnel will supervise the operation of the Health Posts in its area. More importantly, the PHU's will be responsible for immunization, health education, mass treatment programmes, etc. Although no PHU's exist at present, the intention is to make the maintenance phase of the smallpox-measles programme the predecessor of the PHU system. It will form the nucleus around which the other preventive programmes of the PHU can be built.

Forty-four exisiting government hospitals and clinics as well as some mission and concession hospitals and clinics have been tentatively selected as PHU sites. Each PHU will be assigned a specific geographic area of responsibility which will include certain clans or chiefdoms. Since it is financially impossible at present to hire new personnel to staff this system, personnel currently working in the country for the NPHS such as health inspectors and health assistants, will be used. They will devote part of their time to immunization and the remainder to their other duties. It was initially proposed that the 44 men assigned should visit each village once each year to immunize all children between the ages of 6 months and 6 years who had not previously been immunized against measles and to vaccinate all previously unvaccinated persons against smallpox. However, for 44 men to visit 14,000 towns and villages each year is impossible.

An alternative method was needed which provided immunization less frequently than once each year. Susceptibles would have to be allowed to accumulate, but where and for how long? Should the country be divided into 2 or 3 areas, each of which would be covered during one year? This would mean that each area of the country would accumulate susceptibles for 2 or 3 years and from what has been discovered in other programmes in West Africa, this would not have provided effective control of measles.

As a more feasible solution, it was decided that the larger towns should receive priority over smaller ones, particularly those of less than 100 population. This was done because of the following facts:

1. Measles is known to be more continuously present in the larger than in the smaller towns.

2. Larger towns are more exposed to importation of cases from other areas.

3. There is a tendency today for people to migrate from the more remote rural areas to larger towns.

4. The larger towns are more easily accessible by vehicle and the cost of immunizing 100 children in a larger, accessible town is less than the cost of immunizing a smaller group of children in a smaller, inaccessbile village.

To decide on the best system, a detailed evaluation was made of the efficacy of six different approaches to a measles control programme as follows:

1. Immunization of all children as they become susceptible at age 6 months.

2,3,4. Immunization of all susceptible children on a one year, 2 year and 3 year cycle.

5. Immunization annually of all susceptible children in towns over 100 population and the remainder on a 3 year cycle.

6. Immunization annually of all susceptible children in towns over 200 population and the remainder on a 3 year cycle.

In the analysis, the following assumptions were made concerning the attack phase programme:

1. 90% coverage of children in the areas vaccinated.

2. 96% serological conversion rate among vaccinees.

3. The net effective coverage in an area would be, therefore, .90 x .96 or 86%.

The following assumptions were made concerning the maintenance phase programme:

1. Immunization would be performed by 44 vaccinators stationed in 44 Peripheral Health Units distributed throughout the country.

2. 90% coverage of each village or town immunized.

3. 96% conversion rate upon immunization.

As can be seen in Table 1, the most complete coverage is achieved by immunizing all children as they reach the susceptible age of 6 months. However, the health infrastructure required makes this approach impossible at this time. Approach number 2 is likewise impossible because of the large number of towns and villages that would have to be visited each year. The effective coverage of approaches #3 and 4 (2 and 3 year cycles) is very low. The effective coverages of both 5 and 6 are higher than the 2 year cycle approach and require that fewer towns and villages be visited each year. More could be accomplished in the way of measles control by approaches 5 and 6 than by approach number 3 and at a lesser cost.

In conclusion, some alternative approaches to measles maintenance, the exploration of which have been dictated by local demographic and economic factors, have been described. Some general principles have become apparent. They are that measles maintenance programmes should:

1. Begin as soon as possible after the completion of the attack phase in each major subdivision of the country.

2. Be fully integrated with the ongoing and future health programmes of the country.

3. Assign top priority to urban and more densely populated rural areas so that they may be vaccinated annually.

4. Allow for coverage of second priority areas as quickly as it is economically feasible.

Table 1. A Comparison of the Coverage and Efficiency of Various Immunization Programs

Approach	Frequency of Immunization	Percent Net Effective Coverage of Total Population per Year	Number of Villages and Towns to be Visited by One Vaccinator per Year
1	Routine immunization at clinics at age 6 mos.	86	-
2	1 year cycle	86	318
3	2 year cycle	43	159
4	3 year cycle	29	106
5	All towns over 100 pop. each year and all villages less than 100 every 3 years	63	136
6	All towns over 200 pop. each year All towns and villages less than 200 pop. every 3 years	58	121

THEORETICAL AND PRACTICAL PROBLEMS IN MEASLES CONTROL

J. D. Millar[1]

INTRODUCTION

Since 1967, the demands of smallpox eradication have properly pre-empted those of measles control. However, with the rapid elimination of smallpox from all but a few of the 19 countries, the challenge of measles control is attracting increasing interest. This paper describes theoretical studies of, and practical attempts to achieve, measles control.

Measles control is difficult to define in quantitative terms. The common definitions such as "elimination of epidemics," reduction to an "irreducible minimum" or to levels of "public health significance," etc. are imprecise. For our purposes, measles control means the interruption of endemic measles transmission, the prompt notification of imported cases, and rapid control of outbreaks resulting from them. This differs little from usual concepts of measles eradication but it does not imply permanent freedom from measles.

INITIAL DESIGN OF THE REGIONAL MEASLES CONTROL PROGRAMME

While it was known that measles was transmitted far more readily than smallpox and that the disease occurred predominantly among very young children, in 1966 these considerations did not greatly influence plans for the regional immunization drive. Campaigns were designed primarily to achieve smallpox eradication and schedules were constructed to mesh with existing prospection or medical field unit schedules in those countries with such systems. Budgetary considerations also played a role. The basic plan conceived of a three-year vaccination campaign with one-third of each country to be vaccinated each year, all persons were to be vaccinated against smallpox and children six months to six years old against measles.

This design was soon challenged by Drake, NCDC/USAID Medical Officer Advisor, Senegal, as being inefficient and unlikely to reduce measles incidence significantly. He and Gelfand, using life-table techniques, assumed optimal vaccination coverage and vaccine efficacy in each area of a hypothetical country during each year of a three-year campaign. They showed that even after three years of optimal operation, only 40 percent of incoming susceptibles would have been vaccinated before exposure to the disease. Citing the young age distribution of measles in Africa, they felt major measles epidemics would continue to occur. Although the life-table model was useful in appraisal of the problem, it could not effectively analyse the dynamics of measles transmission during and after the vaccination campaign.

THE COMPUTER MODEL

The late Professor George Macdonald of London created a computer model to simulate the West African situation and studied transmission of measles in a model community. The model assumes a steady influx of susceptibles and a high effective contact rate, such that one case gives rise to ten cases among susceptibles and that this high contact rate is constant through the year. As shown in Figure 1, measles transmission proceeds in a pattern not unlike that naturally observed, i.e. epidemics recur every 2 to 3 years as susceptibles accumulate resulting in sharp reductions in susceptibles leading to inter-epidemic troughs of incidence. Macdonald then assumed periodic immunization at intervals of three years and two years and one year (figures 2,3 and 4 respectively). Mass vaccination cycles in which 85% of the target population was vaccinated and which were conducted at a three year and at a two-year interval did little but temporarily suppress impending epidemics. Only an annual cycle of mass vaccina-

[1]Director, Smallpox Eradication Programme, NCDC, Atlanta, Georgia, USA

tion (Figure 4) consistently succeeded in interrupting transmission.

As shown in Figure 5, however, immunization of a child as he becomes susceptible is the most efficient and rapid way to interrupt transmission. Unfortunately, the lack of local health services in Africa precludes a system based on this approach.

The Macdonald model suggests three conclusions: (1) a single mass immunization campaign, no matter how successful, will have no lasting effect on measles transmission, (2) mass immunization campaigns conducted at three year or even at two-year intervals serve only to postpone temporarily measles epidemics (3) mass immunization campaigns at one-year intervals or less are required to assure interruption of transmission.

PRACTICAL ATTEMPTS AT MEASLES CONTROL

The theoretical findings help in interpreting the pattern of measles occurrence in Africa. In two areas, urban Ibadan in Western Nigeria and rural Gambia, provide case studies in which to contrast theoretical considerations with reality.

IBADAN, WESTERN NIGERIA

Ibadan, Western Nigeria, is a major metropolitan area with a population of some 900,000 people. Measles occurred annually until July 1967. In a beautifully executed 10-day campaign, 750,000 persons were vaccinated against smallpox and 72,000 children received measles vaccine. A post-campaign survey revealed a coverage rate of 92% among children 0-3 years of age. Measles transmission sharply declined in Ibadan (figure 6); only 43 cases were seen at the University College Hospital Outpatient Department from August through December in contrast to 764 cases seen there from January through July.

Reported measles cases increased in January 1968; in February 6,400 vaccinations were done in a maintenance campaign aimed at children six to 18 months of age. Reported measles cases continued at relatively low levels and in August 1968, in another maintenance campaign, 4,800 children were vaccinated. Neither maintenance vaccination campaign was followed by an assessment of coverage. In November 1968, reported cases sharply increased and by December, a full-blown epidemic swept the city. Forty-two thousand vaccinations were given in January, February and early March; case figures for March are not yet available.

The cause for the resurgence of measles in Ibadan can be reconstructed. Six months were required to accumulate sufficient susceptibles to permit an increase in incidence in January 1968. The limited campaign of February reduced the number of susceptibles enough to prevent a resurgence of measles in February and March despite the presence of about 20,000 susceptibles in a seasonal environment most favorable for spread. Not until November, after the rains, when over 30,000 susceptibles were present, did measles incidence rise sharply. By the time the epidemic control campaign started, probably 40,000 susceptibles were present in Ibadan.

The Ibadan experience emphasizes the extreme importance of responding vigorously to any evidence of an increase in incidence. It also dramatizes the need for continual awareness of the increasing pool of susceptibles. However, the experience suggests that even in densely populated urban areas, well executed semi-annual maintenance measles vaccination campaigns with high coverage (in contrast to the 30% and 15% in the maintenance programme described above) can prevent the occurrence of epidemics. There appears to be a threshold level of susceptibles, probably approximately 20,000 necessary to permit a recognizable epidemic in Ibadan. Well executed semi-annual campaigns should maintain susceptibles below this level essentially indefinitely.

THE GAMBIA

The Gambia provides a contrast to Ibadan. A small country astride the Gambia River, it has a population of 340,000 people with one major city. Bathurst, (population 32,000). The population density of the country is 90 persons per square mile. From May 1967 to April 1968, the Ministry of Health conducted a systematic country-wide smallpox/measles immunization programme. Overall coverage rates approximated 90% in every division. Maintenance campaigns of immunizations were planned to be conducted annually supplemented by focal outbreak control immunizations where necessary.

As shown in Figures 7 and 8 each divisional campaign was followed by cessation of measles transmission. Since April 1968, only 43 measles cases have been reported throughout Gambia in contrast to 2,700 for the same period the previous year. Nine of the 43 cases since April were imported; three failed to give rise to secondary cases.

The estimated number of susceptibles by month by division is shown in Figure 8. In Western Division and in Lower River Division, measles appeared briefly and then disappeared. In the Western Division, six imported cases gave rise to eight indigenous cases. The maintenance immunizations apparently prevented re-establishment in Gambia despite a year's lapse since conclusion of the mass campaign. Measles control in Gambia is not only possible but has been achieved during the last year. From the available evidence, the annual maintenance vaccination campaigns planned will prove adequate to prevent the accumulation of susceptibles necessary for resurgence of measles.

DISCUSSION

Measles in Africa presents a formidable challenge because of its age distribution. Mass immunization, dependent on mobile units, demands exceptional logistical skill to get to the susceptible child with vaccine before the disease attacks.

Nonetheless, the behaviour of measles in Africa, as elsewhere, appears quite predictable. Several conclusions seem justified from our experience to date:

1. Principles deduced from mathematical models can be of help in planning programmes to interrupt measles transmission.

2. Population size, density and cultural attributes affect the rate of accumulation of susceptibles, the frequency and intimacy of contact, and, the age distribution of disease. From these factors, one can predict the course of measles occurrence and plan maintenance immunization programmes to minimize the chance of re-establishing transmission.

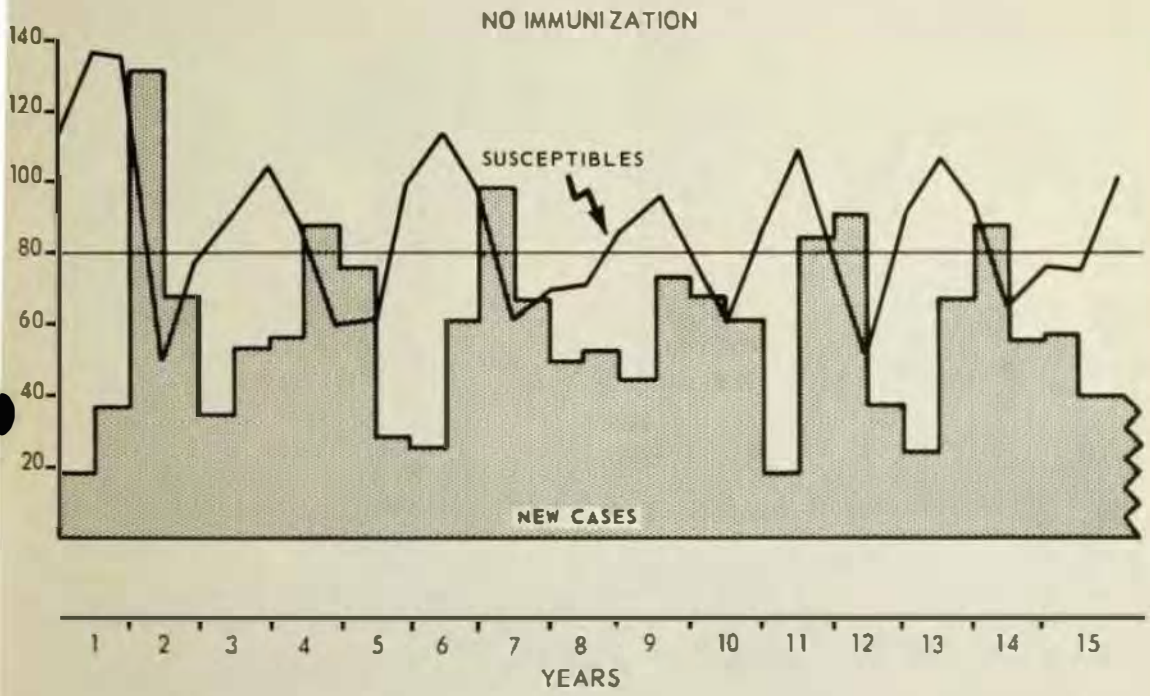
3. Adequate surveillance to detect measles outbreaks quickly and vigorous epidemic control are critically important to prevent re-establishment of transmission.

4. Experience in both urban and rural Africa suggests that measles transmission can be eliminated for long periods of time despite limitations in resources and the absence of a well developed medical care system.

More specifically, semi-annual immunization campaigns, if well executed can control measles in densely populated urban areas; in less populous rural areas, annual campaigns, again well executed, should suffice. From the available data, it appears that even longer lapses between vaccination campaigns may be tolerable in more remote and sparsely populated rural areas depending on local population characteristics. Success in these ventures, however, presupposes the will to continue operating at a high level of efficiency, and more particularly to maintain a sensitive and very responsive surveillance system.

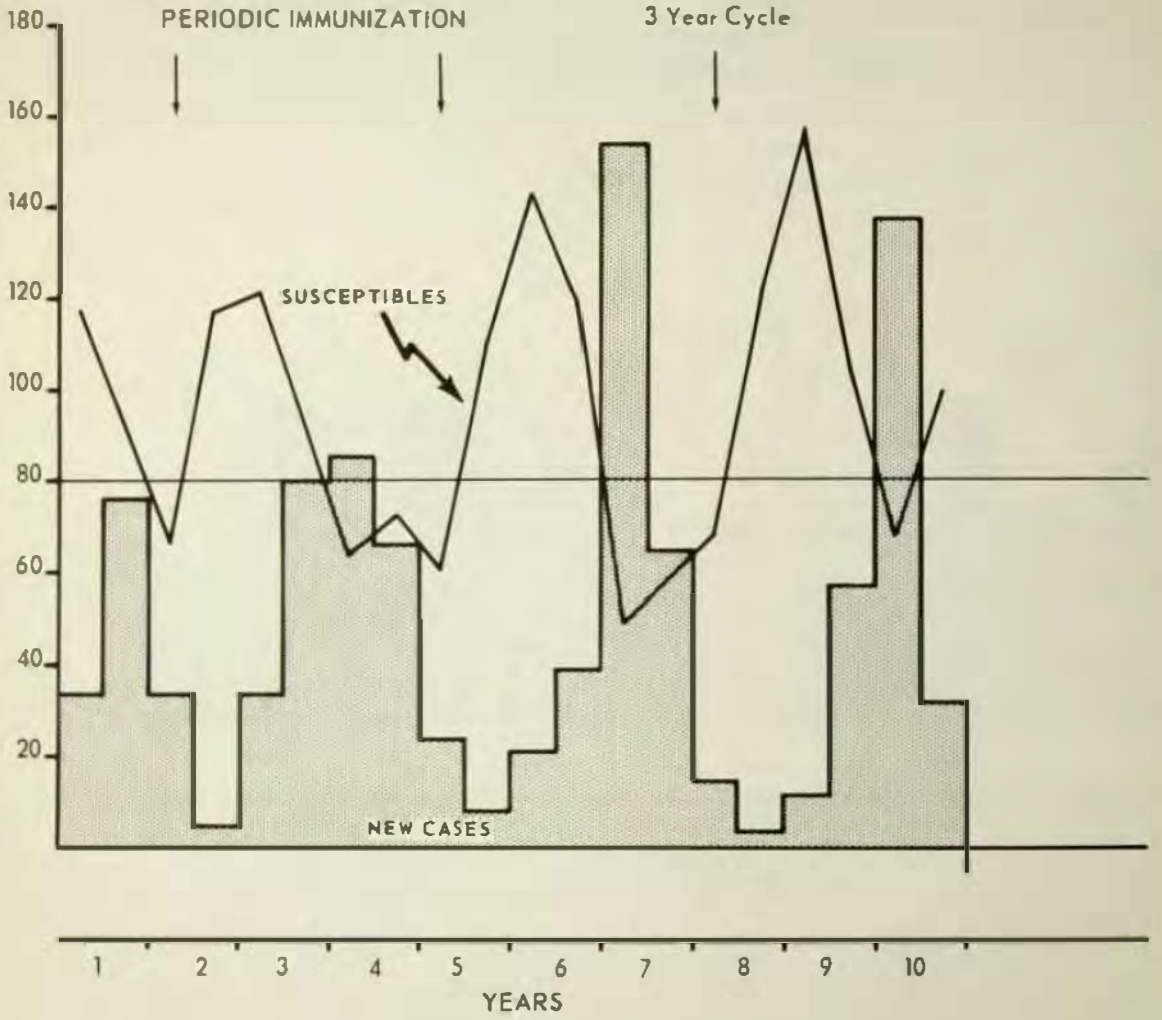
I believe that measles is potentially eradicable in West Africa provided the resources and the will are present. Evidence for any epidemiologic barrier to measles eradication appears to be vanishing rapidly.

FIGURE 1
THEORETICAL MEASLES MODEL*



*Macdonald, G., 1967.

FIGURE 2
THEORETICAL MEASLES MODEL*



*Macdonald, G., 1967.

FIGURE 3
THEORETICAL MEASLES MODEL*

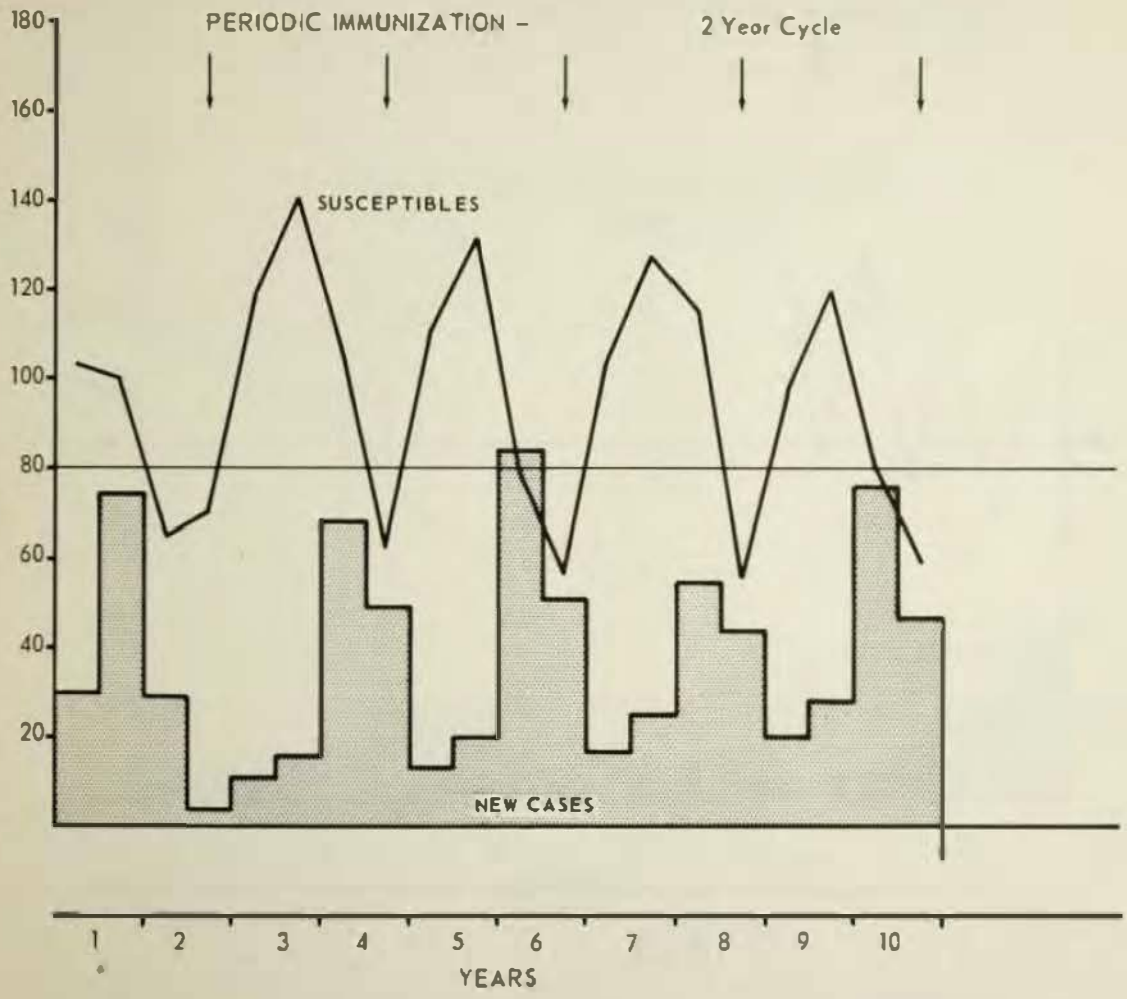


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FIGURE 2
THEORETICAL MEASLES MODEL*

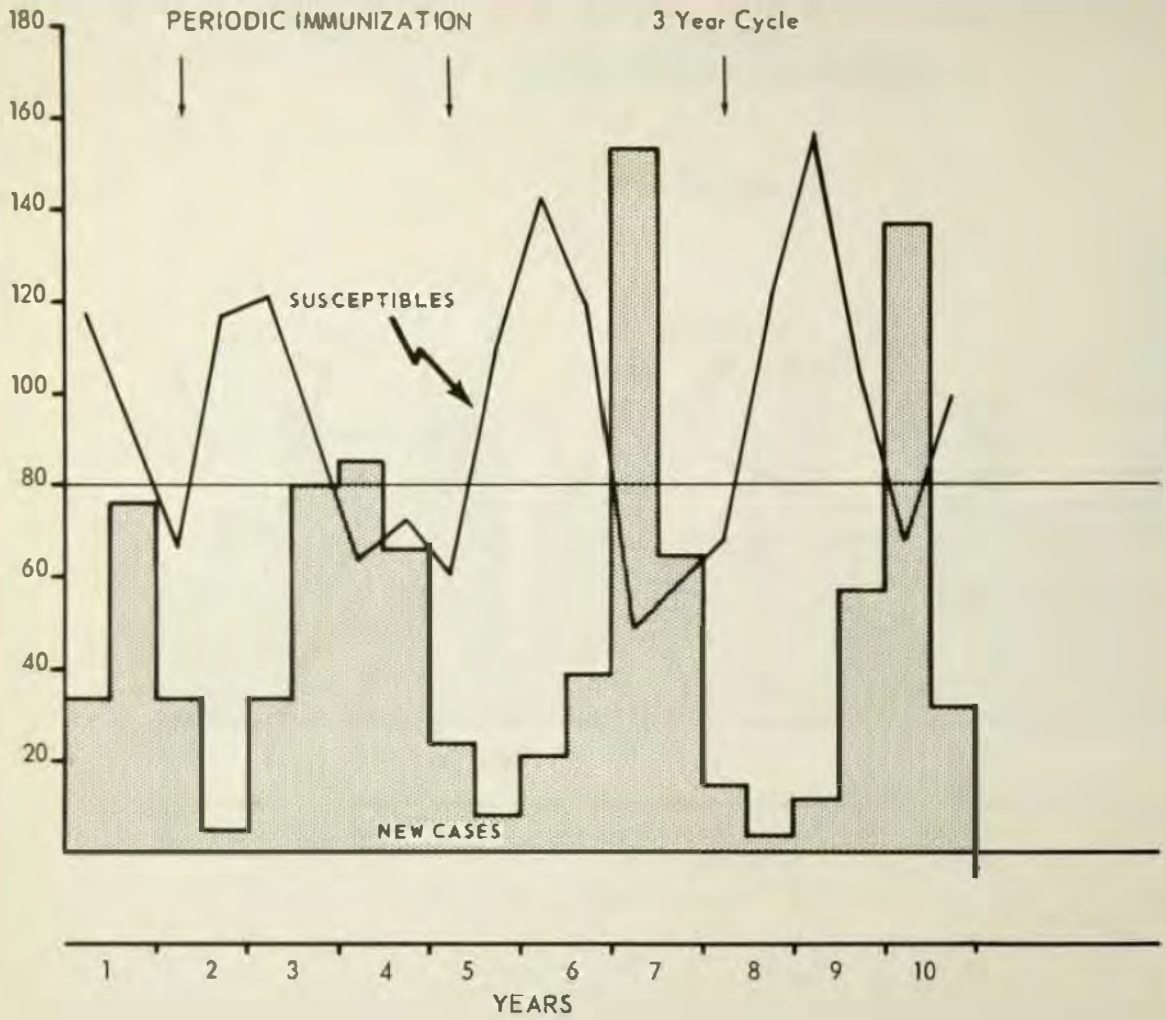

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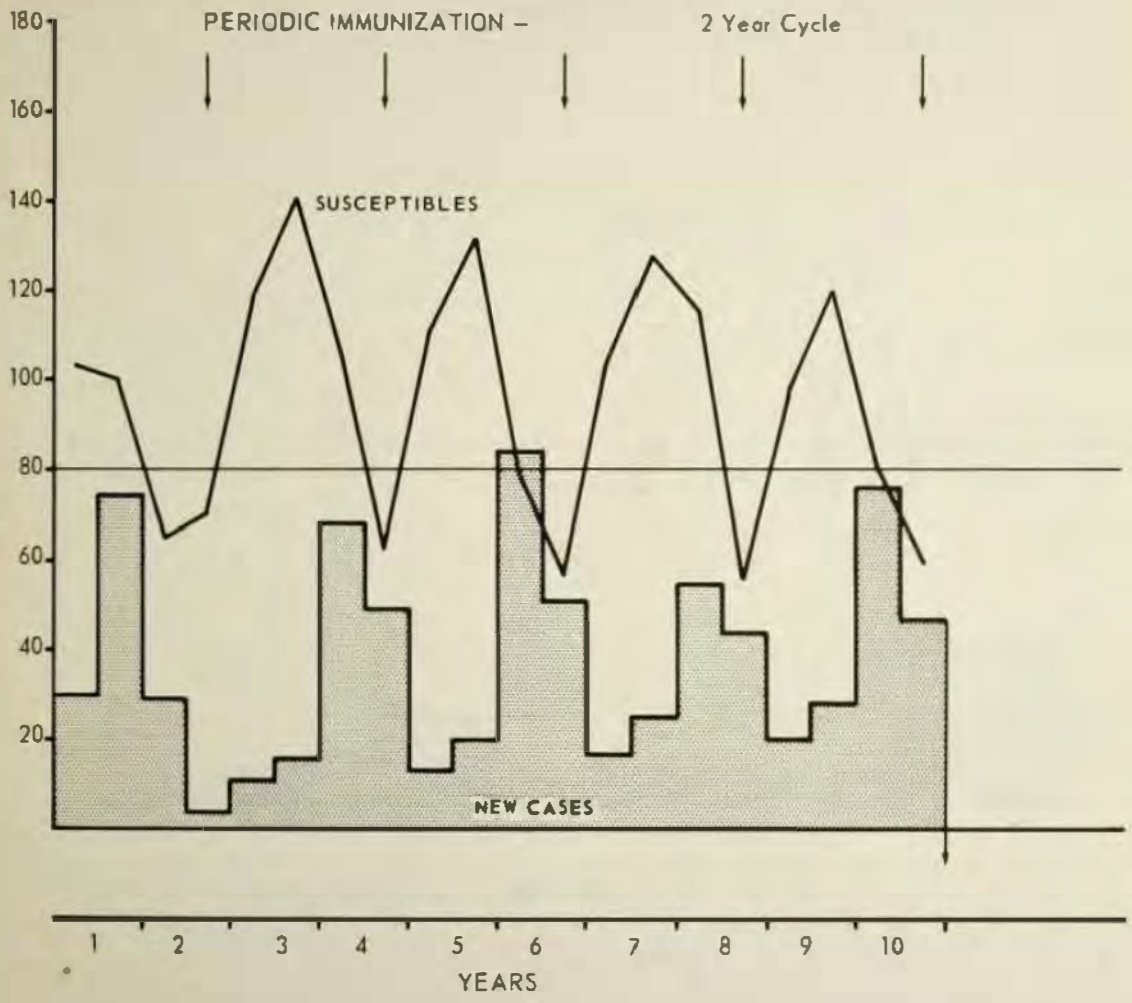
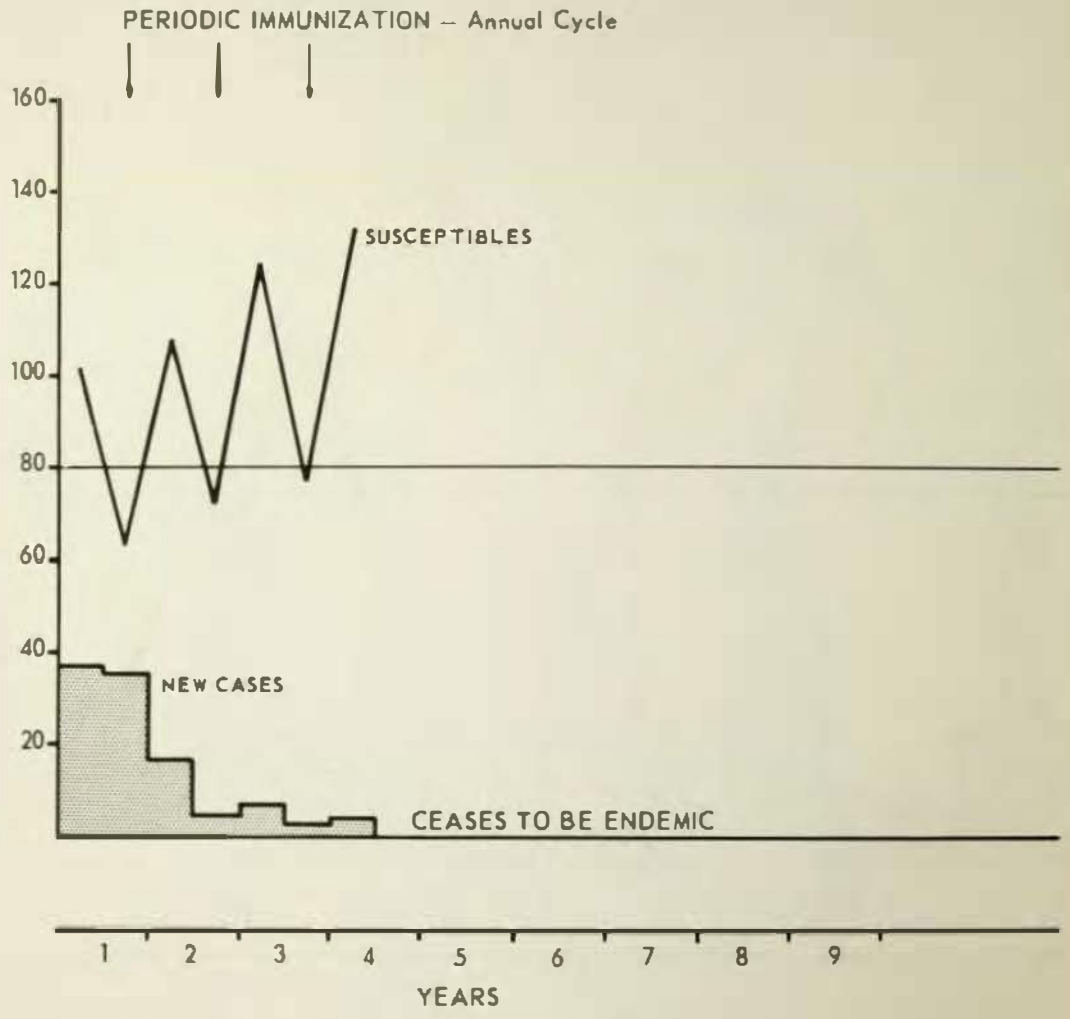
FIGURE 3
THEORETICAL MEASLES MODEL*



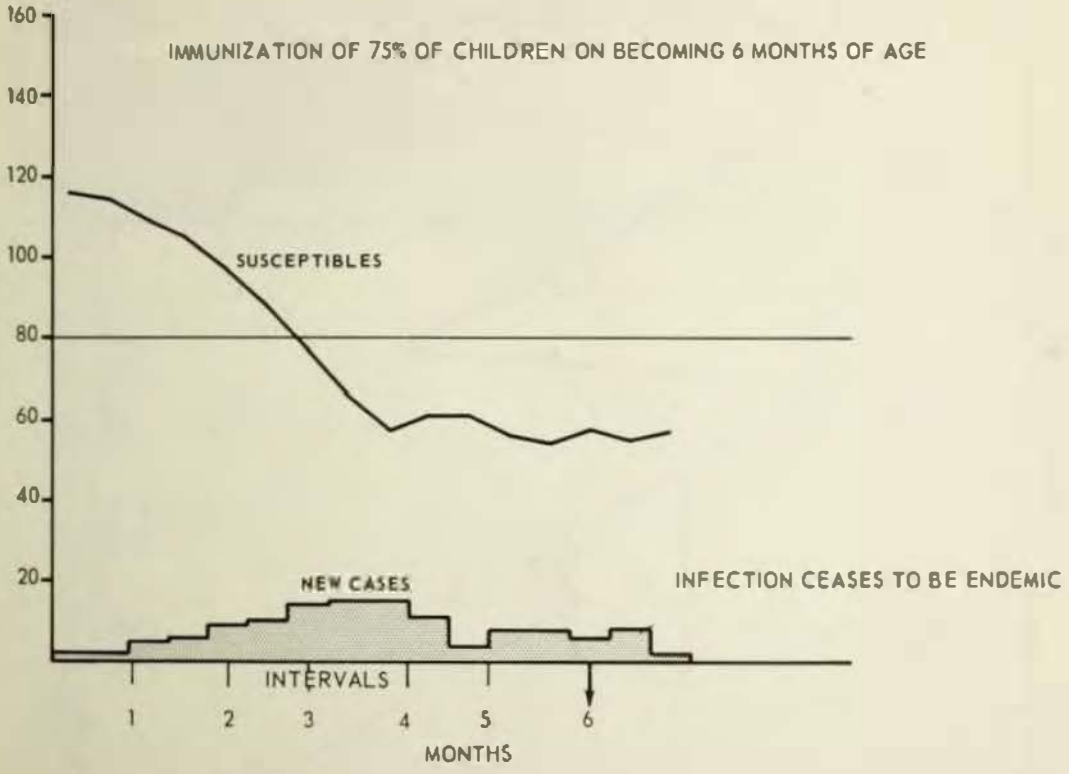
*Macdonald, G., 1967.

FIGURE 4
THEORETICAL MEASLES MODEL*



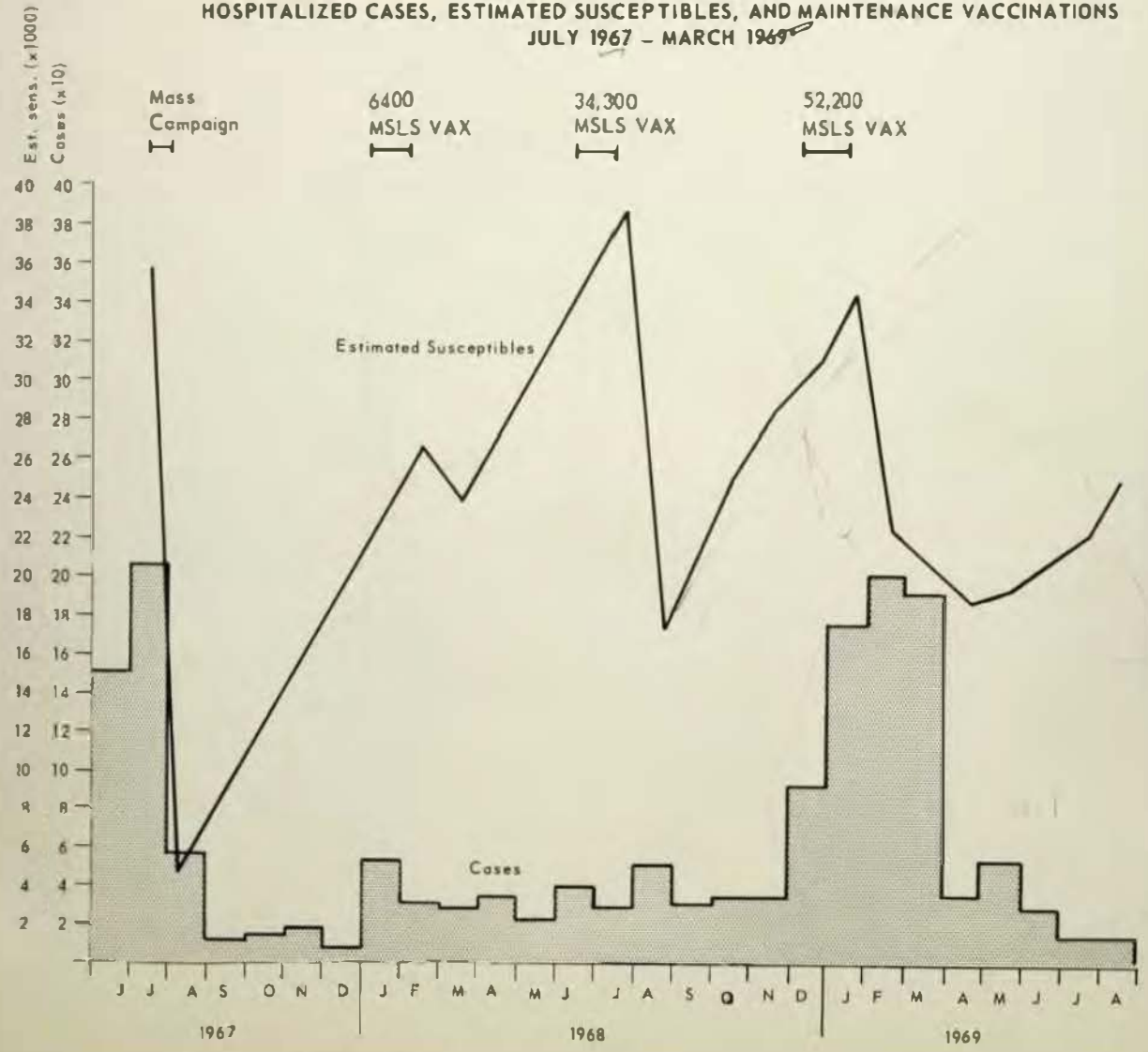
*Macdonald, G., 1967.

FIGURE 5
THEORETICAL MEASLES MODEL*



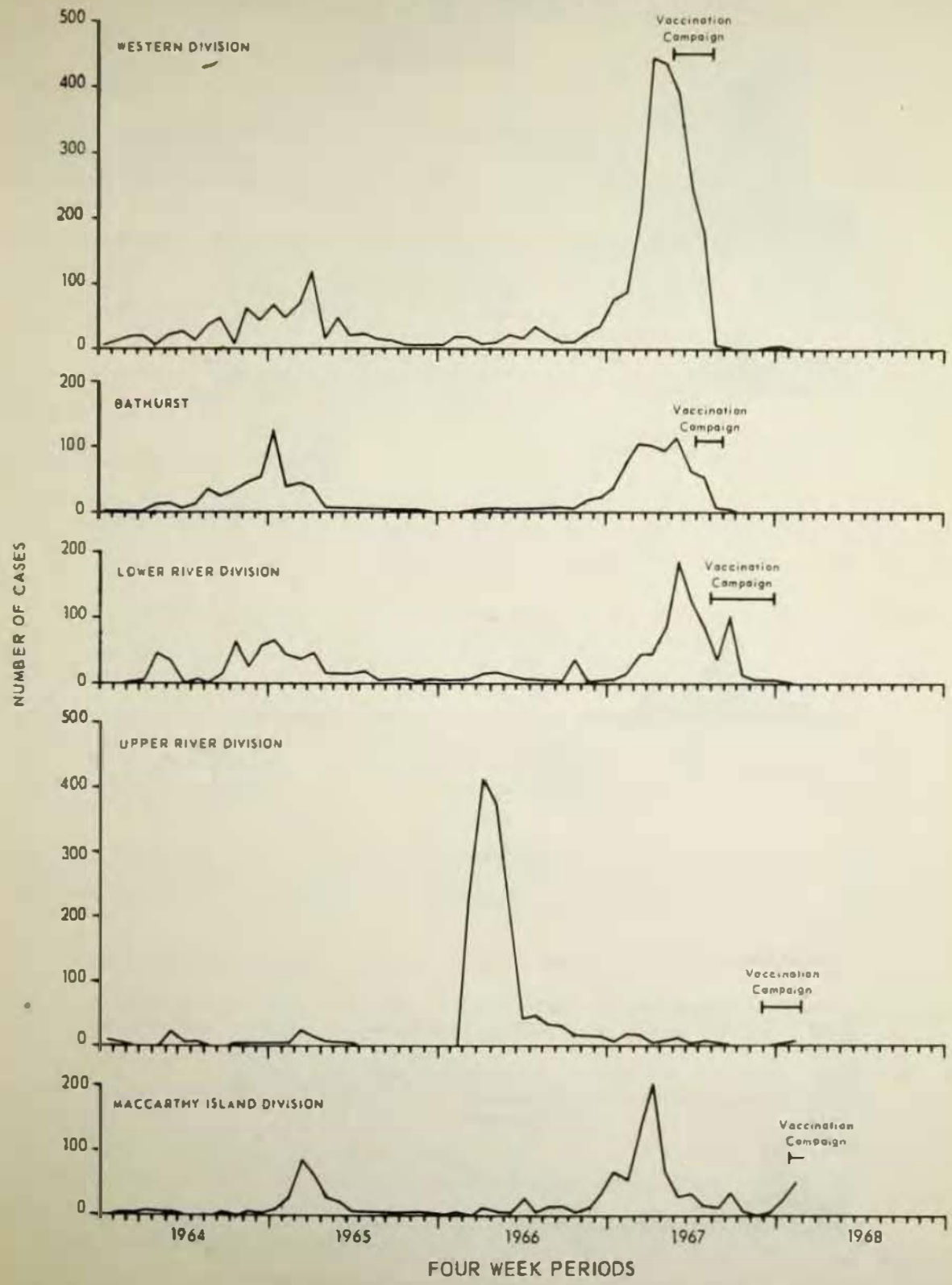
*Macdonald, G., 1967.

FIGURE 6
MEASLES – IBADAN, W. NIGERIA
HOSPITALIZED CASES, ESTIMATED SUSCEPTIBLES, AND MAINTENANCE VACCINATIONS
JULY 1967 – MARCH 1969



PERSONAL COMMUNICATION

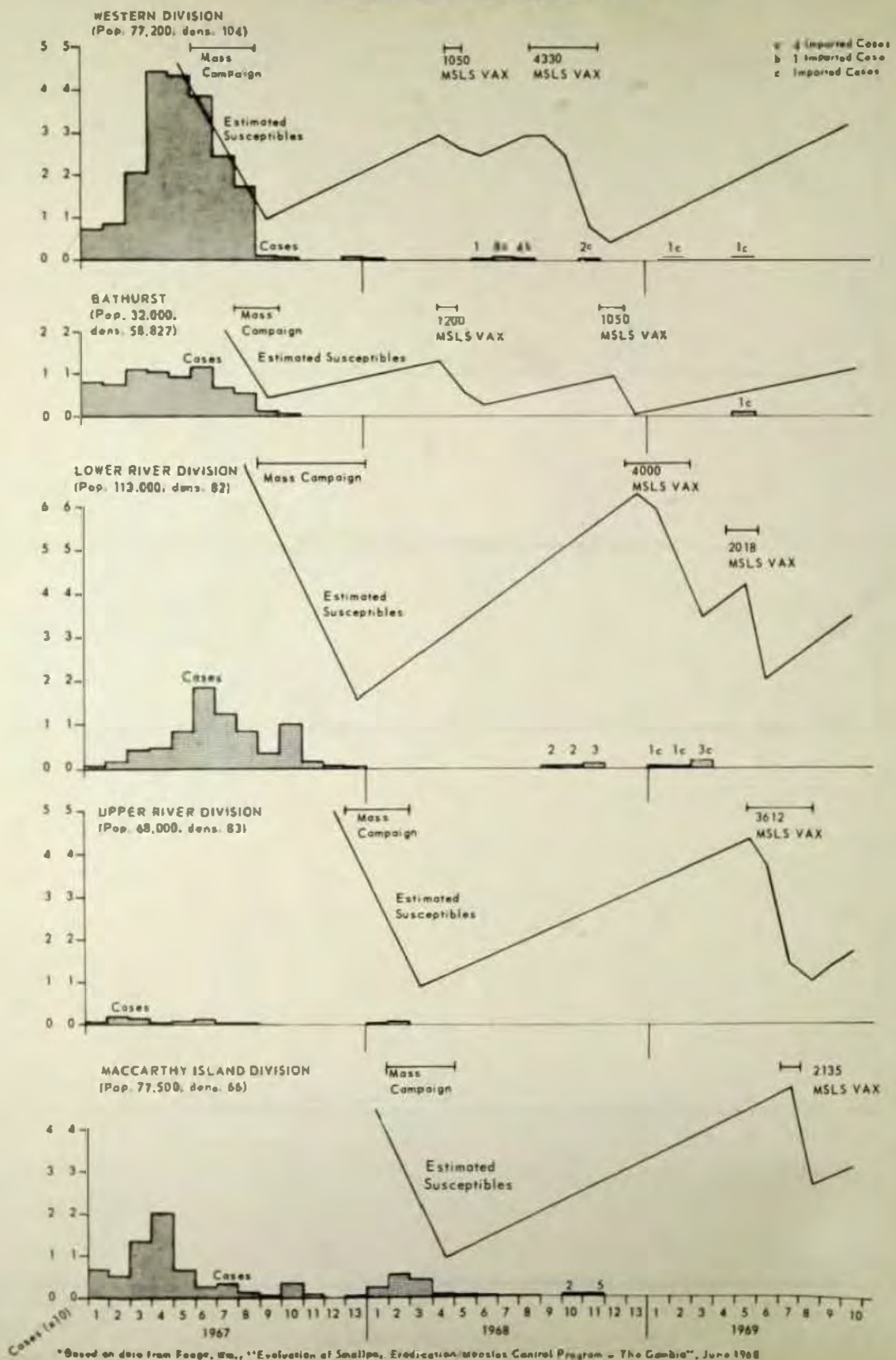
FIGURE 7
SEQUENCE OF VACCINATION CAMPAIGN . THE GAMBIA*



*Foege, William. "Evaluation of Smallpox Eradication/Measles Control Program - The Gambia," June 1968.

FIGURE 8

MEASLES, THE GAMBIA (JANUARY 1967 – MARCH 1969)
REPORTED CASES, ESTIMATED SUSCEPTIBLES, AND MAINTENANCE VACCINATIONS
BY FOUR-WEEK PERIODS BY DIVISION*



*Based on data from Foege, Wm., "Evaluation of Smallpox Eradication Measles Control Program – The Gambia", June 1968 and Measles Surveillance Data, SEP, NCDC, Atlanta.

SMALLPOX ERADICATION IN AFRICA: PRINCIPLES FOR ACTION IN THE MAINTENANCE PHASE

B. Binson[1]

INTRODUCTION

The methods of smallpox control now in use are in complete contrast to those aimed at suppressing epidemics of the disease. The campaigns now being conducted are no longer solely concerned with dealing with epidemics, but, by virtue of their continuity and coverage, are aimed at the eradication of smallpox.

The criticisms to which the use of the word "eradication" has been subjected in connection with the control of communicable diseases, are well known, and especially so in respect of the efforts to eradicate smallpox, an aim which has been considered to be too ambitious. Fortunately, spectacular results have countered these arguments and have demonstrated that the objectives cannot be dismissed a priori as utopian.

Facts have shown that smallpox eradication is possible and that we may hope, provided that we do not prematurely "eradicate" the programmes, to remove the disease from the list of those occurring in Africa.

THE CRITERION OF ERADICATION

Eradication may be defined as the long-term elimination of the clinical disease by the carrying out of a vaccination programme which results in the interruption of transmission and the creation, among the population, of sufficient immunity so that imported cases of smallpox no longer constitute a danger.

Given the fragmentary character of experience acquired in smallpox control, and taking into account the seasonal and geographic variations in incidence of the disease, it is not possible to provide a universal definition in quantitive terms (i.e. duration of time without cases, etc.) as to when eradication has been achieved.

A recent investigation covering nine countries in West Africa* has shown that, in these countries, smallpox is a disease which is both endemic and epidemic in character, with epidemics separated by periods of low incidence lasting for three to four years. Thus, a decrease in incidence cannot necessarily be considered to be the result solely of action taken against smallpox.

Before a country can be said to be smallpox-free, particularly in regions in which the disease is both endemic and epidemic in character, the period which must elapse with no endemic cases must be determined on the basis of the longer-term periodicity of the disease.

The following definitions are proposed:

- a smallpox free country is one in which no cases of endemic smallpox have occurred for a period at least equal to the usual period between epidemics.

- a country which is exposed to the disease is one in which transmission has been interrupted for a period less than the normal period between epidemics.

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[1]Chief Medical Officer, Institute of Hygiene, Abidjan, Ivory Coast.

* July 1968 - Smallpox in the Ivory Coast and in neighbouring countries (Dahomey, Ghana, Guinea, Upper Volta, Liberia, Mali, Sierra Leone and Togo)

Thus, at the present time, none of the countries studied may be considered as "smallpox free", even if the disease is not endemic, and those in which the greatest steps forward have been taken must still be considered as "exposed to the disease". In these countries, eradication may be considered as having been achieved when no endemic cases of smallpox have occurred for five years, provided that, as long as the disease still occurs in adjacent countries, the immunity of the population is maintained.

PROGRAMME OF ACTION IN THE ATTACK PHASE

Smallpox eradication calls for perfect planning.

Experience has shown that a mass campaign, if properly carried out, may be enough to interrupt transmission, eliminate the remaining foci, and leave behind only isolated residual cases, due to the persistence of the virus in remote areas or to imported cases.

It is at this stage that maintenance activities should begin which are aimed at further increasing the vaccination coverage and improving the results already obtained. The persistence of smallpox is possible only by transmission from one person to another, the elimination of susceptibility leads to the eradication of the virus.

The disease is considered to be no longer endemic when no case has been reported for a certain period of time after a systematic vaccination campaign. The determination of the length of this period is linked with the quality of the system of surveillance available. In a country equipped with an effective system of surveillance, it may be accepted that "one or two years" would be enough time for smallpox to manifest itself by spreading from an unknown focus to a region under surveillance. In a country which borders on an infected area, and in which surveillance is still inadequate, this period may be insufficient and the attack phase may have to be supplemented by one or more mass campaigns.

STRATEGY OF THE MAINTENANCE PHASE OF ERADICATION

We may define a maintenance programme as the sum of all those planned permanent activities aimed at protecting a country or region from imported cases of smallpox.

Most frequently, mass campaigns are entrusted to specialized teams because they cannot be assigned to inadequately developed or merely inactive local health services. The campaigns cover the various communities at intervals to assure adequate coverage of newborns and immigrants.

When a period of time has elapsed such that it is certain that smallpox has disappeared, mass campaigns are no longer worthwhile, since the effort involved is out of proportion to the risk. Provided that new programmes can be satisfactorily substituted, the discontinuance of such campaigns would be beneficial.

It would be unreasonable to assign to specialized teams, capable of covering an entire country in three years, the responsibility for vaccinating each year all new arrivals over the whole of the territory. Ultimately, progressive integration is necessary for economic reasons. However, only those responsibilities and duties should be assigned to the general health services which they are capable of undertaking. It is known from experience that integration is not an easy matter and in all probability, there is not a single African country in which, when the attack phase has been terminated, all the maintenance activities can be entrusted to the local health services. Whatever, smallpox control activities must be integrated in a stepwise manner if the results obtained are not to be endangered.

It must also be recognized that in a country in which an endemic case of smallpox has not occurred for years but which remains in a state of alert because surveillance is still inadequate in neighbouring countries, it will be necessary to continue with a much more aggressive vaccination programme.

PLANS FOR THE MAINTENANCE OF ERADICATION IN THE IVORY COAST

The last cases of smallpox in the Ivory Coast were observed in June 1965. The attack phase (third mass campaign) is being completed and a maintenance programme is in course of study. In view of the situation in neighbouring countries, the maintenance of a high level of immunity is necessary.

We envisage a limited degree of integration, with the public health units being entrusted with a specific proportion of the work, depending on their capabilities, as determined by investigations carried out on the spot. For this appraisal, population data have been obtained for each locality and age-group, and the birth rate, infantile mortality and annual figures for emigration and immigration have been determined.

Because of its triennial rhythm, the mass campaign has not achieved complete coverage; a high proportion of young people and immigrants remain susceptible and must be protected. Maintenance vaccination must cover, in addition to infants, who are the first priority, certain children who do not attend school and are, therefore, less easily reached for vaccination purposes than school children, and immigrants, both at the frontier and in the outlying suburbs of towns, where they tend most often to settle.

Some 50 public health units will be called upon to cooperate in the vaccination of newborn and young children in areas for which they are resposnbile. Wherever they exist, the maternal and child care services (PMI), and the hygiene and school medical services (IMS) will participate in the activities.

National programmes for the control of communicable diseases are in course of implementation, to which will be linked smallpox control activities associated with surveillance and maintenance. The mobile teams of the Service des Grandes Endemies will have an important part to play.

Localities not included in these programmes and those not covered for various reasons, will be visited by teams from the Institute of Hygiene.

Vaccination coverage of children born after the last visit of a specialized team will have to be practically complete. A simple formula has been worked out for determining the numbers which should be vaccinated. This formula is based on the size of the population in question, taking into account the date of the last visit and the death rates of the different age groups. This figure will be considered, for each locality, as the minimum number of vaccinations necessary to obtain adequate coverage. Those in charge of the mobile teams will have this method of calculation explained to them but will be left free to vaccinate systematically all persons without a vaccination scar.

The population of the Ivory Coast increases by about 40,000 each year as a result of immigration. Uncontrolled crossings of the land frontiers constitute a danger which must be eliminated by vaccinating all foreigners not in possession of a valid certificate, whatever the length of stay envisaged. While surveillance at the air and maritime frontiers functions normally, control of the land frontiers must be introduced. The places where such control will be carried out have been selected and plans have been made to implement such control. Inter-state cooperation is desirable, since it would be advantageous for the competent authorities to come to an agreement to collaborate in covering the land frontiers rather than to do so in isolation as a single frontier post should be sufficient to control all crossings in a given sector.

Legislation aimed at protecting the population of the Ivory Coast against smallpox has been developed over the years. The attack phase of the programme has thereby been facilitated and, providing that certain changes are made, the legislation in force should assist in the maintenance of eradication. In addition to compulsory vaccination, compulsory notification of cases and treatment, and powers given to the authorities to take urgent measures, the possession of a medical vaccination card, are also compulsory. The issuance of a vaccination card has been an important factor in the success of the mass campaigns, since it facilitates control and stimulates a high proportion of attendance. This practice is indispensable in the maintenance phase.

The obligation of parents and employers have been laid down in the legislation. The same applies to the periodic revaccination of administrative personnel, and every applicant is required to present a valid certificate. Special provisions applicable to public health personnel are to be proposed. It will also be requested that the issuance of certain official documents (identity cards, construction licenses, hunting licenses, driving licenses, etc.) should be made subject to the presentation of a valid certificate, and finally, that the requirements already imposed on air lines and shipping companies, in respect to the issue of licenses, should be extended to cover rail and road transport.

CONCLUSIONS

The development of smallpox control in Africa has shown that the eradication of this disease is an attainable objective on a continental scale.

The specialized attack teams of the preventive services have everywhere proved their effectiveness.

In the maintenance phase, provided that their responsibilities are not out of proportion to the equipment and funds available to them, the local health services, by their participation, should improve the level of immunity.

There is no great difficulty in stopping the advance of epidemic smallpox, and it is only logical to make the effort necessary to eliminate the endemic disease.

When the disease has apparently disappeared, and it seems, at first sight, that there is no need for the activities to be continued, eradication can be maintained successfully only if those responsible persevere and if the authorities, who provide the necessary funds, give their continuing support.

MAINTENANCE OF SMALLPOX IMMUNITY AMONG THE NOMADS

Issoufi Alzouma[1]

INTRODUCTION

The nomadic population of the Republic of Niger amounts to about 530,000 inhabitants belonging to various tribes, of which the most important are the Peulhs, the Touaregs, the Bororos, the Bellas, the Arabs and the Toubous. These nomads live mainly in the Sahel-Sahara region of the Republic, but they may be found everywhere throughout the region occupied by the settled population. At the present time, the government policy is to encourage them to settle down, and the establishment of new cities, thanks to the discovery of large deposits of uranium in Niger, will be of great assistance in this.

For disease surveillance and to improve the health of the nomadic population the Government of the Republic of Niger uses two types of medical services:

1. the fixed medical services, constituted by the dispensaries;

2. the mobile medical services, constituted by the Mobile Teams for Hygiene and Mobile Medical Care, and by the OMNES (the Niger Organization for Mobile Medical Care and Health Education). These mobile medical services are employed wherever necessary to provide protection to the population, whether nomadic or settled, against present or threatened outbreaks of the communicable diseases.

In spite of the mobility of these teams and the efforts which have been made, it has been difficult to vaccinate the desired goal of 90% of the nomad population as the nomads are, of course, perpetually moving about. New solutions to the problem are necessary.

The difficulties are chiefly of two kinds:

1. Transportation

   The terrain is difficult at all times of the year. As there are virtually no roads in the region inhabited by the nomads, it is necessary to follow the roughest of tracks from tribe to tribe in order to carry out vaccination.

2. Dispersion of the Population

   The majority of the nomads are absent from their territory during the dry season, a period in which it is easiest for our teams to move about.

The nomads disperse in search of pasture and of food during this difficult time. The tents are often hidden among the dunes and they cannot be seen without an experienced guide. Fortunately, up to 150,000 of the 530,000 gather together at In-Gall for the salt cure in July, August and September of each year and, during the attack period of 1967 - 1969, 379,000 nomads were vaccinated in their own territory (In-Gall Tchintabaraden, Abalak) at pools and wells, and especially at water sources, where our teams stopped to wait for them.

THE NECESSITY OF MAINTAINING THE LEVEL OF IMMUNITY AMONG NOMADS

It is absolutely necessary to maintain the level of immunity at all times in the nomad regions, since the nomad can serve both as a reservoir and transmitter of

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[1]Technical Officer of Health, Service des Grandes Endemies, Niger.

smallpox over long distances. Not infrequently, the nomad leaves his native region and contracts the disease in another area; as soon as the first symptoms appear, he quickly returns home, where he infects the other nomads. In addition to transmitting smallpox all along his route home, his family and other members of his tribe or group sometimes inoculate themselves from his pustules. Due to the remoteness of the region inhabited by the nomads, there is also very frequently a prolonged delay in the notification of cases.

In view of the difficulties which may be encountered at all times and particularly during the hot season, techniques for the execution of maintenance programmes require detailed investigation before being undertaken.

The problem is a very difficult one, but not insoluble. It is necessary, not only to carry out vaccination in the region inhabited by the nomads, but also to vaccinate every nomad wherever he may be found unless he possesses a vaccination card issued less than three years previously. This measure must be applied to all those moving from one place to another: travellers, merchants, foreigners, peddlers and shepherds. Experience has shown in Niger that this approach has had the result that, since September 1967, no case of smallpox has been notified from the region inhabited by the nomads, whereas previously 45% of cases were from this region (Filingué, Tahoua, N'Guigmi Dokoro).

INVESTIGATION OF IMPORTED CASES DURING THE SMALLPOX ERADICATION PROGRAMME IN CAMEROON

A. Delas[1]

This report describes the experience in Cameroon in the control of smallpox foci since January 1967, i.e. since the beginning of the regional programme for the eradication of smallpox and the control of measles.

INTRODUCTION

There are 24 medical sectors (Figure 1) in Cameroon, each of which is under the direction of a physician, who is responsible for the vaccination and survey teams. In addition, he is responsible for reporting immediately, by telegram, every case of smallpox which occurs. He also has the main responsibility for taking control measures in the event of an outbreak.

Each medical sector normally uses the regular vaccination and survey team in the control of outbreaks, each team generally containing 7 to 15 nurses. In Sector 11, however, where the greatest number of foci and of cases have been found, a special team was established in 1967. This team carries out active surveillance for cases of smallpox and is responsible for investigating and controlling any epidemics which may occur.

CASES OF SMALLPOX SINCE JANUARY 1967

Since January 1967, a total of 159 cases of smallpox have been detected in Cameroon. All have occurred in the four sectors located in the extreme north (sectors nos. 8, 10, 11 and 13). In the period between January 1967 and the end of January 1969, there were 21 different outbreaks. Sector 8 had two outbreaks with a total of six cases; Sector 10, one outbreak with seven cases; and Sector 13, two outbreaks with 50 cases. The remaining 96 cases were associated with 16 outbreaks in Sector 11.

Table 1 summarizes the information on the 159 known cases which have occurred up to the present.

SOURCES OF INFECTION

The source of infection has been carefully looked up for each focus, and it will be seen from Table 1 that in four outbreaks only was the source of infection not definitely established. Of the total 21 outbreaks observed during the 26 months under consideration, 17 are known to have directly or indirectly originated from infection acquired in Nigeria and one additional outbreak (No. 7) is strongly suspected of having a similar origin. Thus, for the provinces of north Cameroon, the only major source of infection is Nigeria, where smallpox has been endemic for many years.

Fortunately, a smallpox control programme has now been initiated in Nigeria which should soon begin to show results.

CONTROL OF CASES - THE MEASURES TAKEN

Control of the frontier between Cameroon and Nigeria is absolutely impossible. Numerous mountain tracks are used in both directions, and villages and markets exist on the frontier itself. Surveillance of cases and an increase in the vaccination coverage in the two countries concerned are the only measures possible to achieve control of the disease.

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[1]Assistant Director, Service des Grandes Endémies, Cameroon.

Of the 21 outbreaks which have occurred since January 1967, there were seven outbreaks which began in 1967, the average number of cases per outbreak being 18.3 (Table 2). Eleven outbreaks began in 1968, the average number of cases per outbreak being 3.4. In 1969, there have been three outbreaks, each with a single case. Thus, a marked decrease in the number of outbreaks has been noted since the beginning of the programme and the size of the outbreaks has progressively decreased. These changes we attribute to the effect of mass vaccination and to the improvement of measures for control and surveillance.

In addition, the average delay between the time of occurrence of the first case and that of the investigation decreased from 7.1 weeks in 1967 to 2.8 weeks in 1968 and to 1.0 weeks in 1969.

Vaccination of an entire canton was carried out in the containment of 10 outbreaks; for six outbreaks, we vaccinated the zone concerned and markets; and for five outbreaks, we vaccinated only contacts and kept them under surveillance.

It should be noted that in one focus only (No. 3), new cases of smallpox were observed more than two weeks after control measures had been taken. In all the other foci, the spread of the disease was rapidly brought to a halt.

At the present time, strict measures have been adopted in Cameroon for the detection and rapid control of all supposed cases of smallpox.

1. Each health centre in the northern region (sectors 8, 10, 11 and 13) is responsible for informing the sector head within 48 hours of any suspected case of smallpox within the area for which it is responsible. The same applies to the administrative and tribal authorities. Failure to perform this duty is punishable by severe penalties.

2. The sector head must, within 24 hours, warn by telegram the Ministry of Health at Yaoundé of every case of smallpox confirmed by him.

3. Without waiting for further instructions, the sector head must carry out the necessary preventive and mass vaccination operations around the new cases.

4. As soon as we have received an additional vehicle, a special surveillance team will be organized, trained and established in North Cameroon.

Table 1.

Outbreak No.	Sector	Onset: First Case	Onset: Last Case	Source	Total Cases	Age: 0-4	Age: 5-9	Age: 10-14	Age: 15-25	Age: 25+	Age: Unknown	Date of Investigation	Action Taken
I. 1967													
1	8	23 Jan	23 Jan	Not found	1					1		Immediate	Canton vaccinated
2	11	April	April	Maiduguri, Nigeria	1				1			21 April	Canton vaccinated
3	11	20 June	25 Aug	Maiduguri, Nigeria	49	6	3	5	6	29		20 July – 27 Sept. (6 visits)	Area markets vaccinated
4	11	15 Aug	5 Sept	Nigeria	3					3		29 Aug, 6 Sept	Canton vaccinated
5	8	15 Sept	18 Nov	Gamarov, Nigeria	5	1	2	2				30 Nov	Area vaccinated
6	11	Nov.	25 Dec	Previous Outbreak-Cameroon	11	1			2	8		9 and 26 Feb	Contact vaccination; surveillance
7	13	Dec	4 Mar	? Nigeria	49		2		9	26	12	28-30 March	Canton vaccinated
II. 1968													
8	11	16 Jan	16 Jan	Bama, Nigeria	1					1		10 Feb	Ring vaccination; surveillance
9	11	27 Feb	10 Mar	Not Found	2					2		15 March	Area vaccinated; surveillance
10	11	5 Feb	20 Mar	Madagali, Nigeria	11		1	1	3	6		25 March	3 cantons vaccinated; surveillance
11	11	5 Mar	24 Mar	Not Found	2	1				1		26 March	Canton vaccinated; surveillance
12	11	14 Apr	14 Apr	Gouloumba, Nigeria	1					1		15 April	Market vaccinated
13	11	5 Apr	5 Apr	Soya, Nigeria	1				1			15 April	Canton vaccinated; surveillance
14	11	4 Apr	May	Banki, Nigeria	3		2		1			16 April	Canton vaccinated
15	11	April	30 May	Nigeria	3	1					2	10 June	Surveillance
16	11	15 Dec	15 Dec	Banki, Nigeria	1					1		20 Dec	Surveillance
17	10	8 Dec	7 Jan	Banki, Nigeria	7	2		1		4		26 Dec 6 and 10 Jan	Area vaccinated; surveillance
18	11	17 Dec	5 Jan	Banki, Nigeria	5			1	1	3		3 and 10 Jan	Area vaccinated; surveillance
III. 1969													
19	11	19 Jan	19 Jan	Outbreak 17, Cameroon	1					1		31 Jan	Canton vaccinated surveillance
20	11	20 Feb	20 Feb	Banki, Nigeria	1					1		24 Feb	Surveillance
21	13	20 Feb	20 Feb	Outbreak 17, Cameroon	1						1	24 Feb	Surveillance

Table 2. Indices of the Effectiveness of Surveillance - Cameroon

Year	No. of Outbreaks	Average No. of Cases per Outbreak	Average Interval between 1st Case and Investigation (weeks)
1967	21	18.3	7.1
1968	11	3.4	2.8
1969	3	1.0	1.0

FIGURE 1
SMALLPOX OUTBREAKS IN THE CAMEROON – 1967-1969 (January)

SUMMARY

J. D. Millar[1]

We previously identified the principles of the maintenance programme but for emphasis I repeat them:

a) To eliminate the accumulation of susceptibles by immunization.
b) To assure high coverage in such campaigns through concurrent assessment.
c) To identify and control outbreaks.

In the maintenance phase of the programme the priorities regarding measles control must be carefully determined by each country. We are not really able to talk yet about maintenance of measles control; the initial achievement of measles control throughout the 19 country area is still limited geographically. However, one may at this point highlight certain of our experiences:

a) The success of measles control in The Gambia is clearcut and it appears that The Gambia at least has every hope of maintaining measles control through an annual nationwide vaccination cycle.
b) In Ibadan, Nigeria, a surprising epidemic developed. On careful examination, it appears that the cause was due to an accumulation of susceptibles in the population primarily as a result of low coverage in the age group six months to one year. Other factors may have been involved, specifically population migration.
c) The experience in Kano, Nigeria demonstrates the difficulties experienced in reducing the target age group to young infants and emphasizes the problem of securing high coverage levels in this group. Hope is expressed, however, that greater selectivity can be achieved and, through better dispersion of information, high coverage can be obtained.

Some of the excellent ideas brought forward in the discussion deserve evaluation:

a) The suggestion of a single annual urban campaign timed to occur just before the expected measles season is interesting. Such a campaign might be supplemented by firefighting activities throughout the rest of the year to keep the level of transmission as low as possible.
b) The suggestion to time campaigns according to the ebb and flow of epidemics is also compelling. To evaluate this, one must have information on the cyclicity of measles in various areas. By "tailor-making" programmes for these areas, hopefully we might quickly establish whether such "tailored" immunization programmes can prevent epidemics.
c) The persistent door-to-door search for susceptibles in urban areas deserves study. This practice could be essentially continuous and might be tied to birth registration and infant care schemes to assure adequate follow-up. It will obviously demand a substantial change in the orientation from mobile immunization campaigns. However, in urban areas it may, in fact, represent the modus operandi of the future.

Fortunately, smallpox eradication is much more amenable to maintenance. The effective contact transmission rate in smallpox is less which means that a larger reservoir of susceptibles must accumulate to support continuing widespread infection. There are already several examples of successful maintenance programmes of smallpox vaccination in the 19 country programme. Not only Ivory Coast but also other countries, members of both OCCGE and OCEAC, have shown that repeated cycles of vaccination on a mass basis at three year intervals can keep the pool of susceptibles at levels sufficiently low so that, even when reintroduced, smallpox is a manageable problem.

[1]Director, Smallpox Eradication Programme, NCDC, Atlanta, Georgia, USA.

The discussions have emphasized several problems of importance in the future.

1) Foremost among the problems potentially jeopardizing success of the maintenance phase, is the importation of smallpox from infected areas. The solution of this problem will rest upon the establishment of a surveillance system adequate to detect imported cases quickly, and an investigation and control system adequate to provide rapid handling of cases which are imported.
2) Nomads continue to constitute a problem as regards coverage, and there is no easy solution for this. We must continue to find ways in the maintenance programme to provide reasonable coverage for nomad groups. We should recall our previous discussions, however, which emphasized that nomads, while sometimes important in spreading smallpox from one area to another, appear to be of secondary importance as chronic reservoirs of smallpox infection.
3) The advantages and disadvantages of immunization cards have been discussed at length. They may well have a role in certain circumstances but, in others, they may be quite unworkable. Further studies and observations will be important.

In conclusion it would appear that the suppression of smallpox is relatively easy: the maintenance of freedom from smallpox will require persistence in the vaccination programme as well as adequate surveillance and outbreak control activities. It would appear that any system which is adequate to maintain measles control will be more than adequate for maintenance of smallpox eradication.

We must regard the maintenance vaccination programmes as being of indefinite duration. In many instances, measles and smallpox vaccination activities may become part of a multiple antigen immunization programme; in other instances they may persist as specific activities. Nonetheless until the world is free of smallpox, continued maintenance vaccination programmes will be essential.

It would appear that in the absence of a resumption of endemic smallpox transmission in the 19 country area, and provided that alert surveillance and outbreak control response is sustained, a repeat revaccination of the entire population of the 19 country area will not be necessary. Our objective at this point should be to get everyone vaccinated at least once as soon as possible after birth. The evolving WHO dictum indicates that one primary vaccination, followed by one revaccination should provide a level of immunity sufficient for life in most instances. We express a certain faith in the ultimate success of the global programme in our anticipation that sources of reintroduction of smallpox will be gone within the next few years. If not, the question of revaccination of the total population will have to be considered.

PROGRAMME OPERATIONS

A Review of West and Central African Operations: Methods and Tactics.
J.W. Hicks

The Value, Efficiency and Limitations of Collecting Points in Mass Vaccination Programmes.
E.A. Smith, S.O. Foster, J.I.A. Adetosoye, I.S. Mebitaghan, P.O. Adeoye, J.M. Pifer

Comparative Advantages of the Jet Injectors and the Bifurcated Needles.
G.F. Glokpor

Advantages and Disadvantages of Specialized and Multipurpose Medical Teams.
J.M. Roux

Safety, Efficacy and Priorities in Multiple Antigen Usage.
R.G. Hendrickse

Associated Vaccine Campaigns: Organization and Logistics.
R. Labusquiére

Programme Costs as Related to Vaccinations, Morbidity and Mortality in The Gambia.
P.J. N'Dow

Summary
D.A. Henderson

A REVIEW OF WEST AFRICAN OPERATIONS: METHODS AND TACTICS

James W. Hicks[1]

The progress which has occurred in the West and Central African Smallpox Eradication and Measles Control Programme is an excellent example of what can be done when a group of countries collectively invest their imagination, knowledge and skills to reach a common objective.

The extraordinary challenge of eradicating smallpox and controlling measles in the 19 country area called first for diverse but comprehensive planning. Planning is the preparation for action and must always precede any successful field activity. Planning sessions were held in Africa and the United States among individuals who represented various levels of responsibility in each country, the World Health Organization, the organizations of OCCGE and OCEAC, and the Government of the United States. Project Agreements were mutually developed between each country and the Government of the United States which outlined the objectives, operational plans, and participant responsibilities in each country.

Planning for this particular exercise was of two types: strategical and operational. Strategical planning consisted of deciding specifically the overall objectives for the five year plan and the general strategy for achieving these objectives. It was decided that the overall plan would consist of two phases, Phase I (Attack Phase) and Phase II (Maintenence Phase). Within this plan were developed independent but interrelated projects (e.g. personnel recruitment, training, procurement and allocation of resources, etc.), and detailed consideration was given to each of these in terms of organization, scheduling and management, for the success or failure of the entire programme. Operational planning determined the methods by which the project would be carried out. Primarily it was concerned with performance and the management of resources, for project operations represent the execution of the strategical plan.

In the strategical planning, the Attack Phase, was designed to achieve a high level of immunity in the Project Area against smallpox in the shortest possible time by widespread vaccination of the population in each country. Immunization against measles was to be provided to susceptible children in an attempt to control the number of measles cases. The plan also called for the development of a disease surveillance mechanism which would assure that all suspect cases of smallpox were reported, and that an adequate epidemiologic response capability was available in each country. In operational planning for Phase I, it was decided that the chief means for carrying out the vaccination objectives would be mass campaigns by mobile teams using jet injectors.

Strategical planning for Phase II was concerned with maintaining a high immunity barrier against smallpox throughout the Project Area, and a sufficient immunity level against measles so that measles so that measles morbidity and mortality would remain at the barest minimum, taking into consideration the resources available for measles control in each country. Achieving an appropriate and adequate surveillance programme in each country was also considered a vital objective.

Operation planning for Phase II called for the vaccination against smallpox of all susceptibles in the population, i.e. newborns, persons missed by previous campaigns and immigrants. Immunization against measles would be provided to all susceptible children. Primarily these children would be those who had reached six months of age since the last campaign. Using fixed centres and mobile campaigns in appropriately timed cycles, an important accumulation of susceptibles could be avoided.

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Methods for conducting assessment activities to assure adequate vaccination coverage, and procedures for managing an alert and comprehensive surveillance system with rapid response capability for outbreak control were also defined during operational planning.

Three general areas of participation and responsibility were delineated. First, at the country level, new or modified programmes would be implemented to meet the country's particular objectives as part of the overall regional goal to eradicate smallpox and control measles. Second the National Communicable Disease Center (NCDC) in Atlanta, Georgia, as headquarters for the US participation in the Programme, would provide technical advice through onsite advisers, and would maintain liaison with the Agency for International Development which would fund the American contribution. The NCDC would be chiefly concerned with the selection, training and support of the assigned technical advisers, the procurement and distribution to Africa of major commodities, and the cooordination of programme matters with other national and international groups participating directly or indirectly in the Project. Third, a Regional Office based in Lagos, Nigeria, would provide programme coordination and specialized consultation to project countries in the areas of epidemiology, administration, statistics, health education, equipment maintenance, smallpox vaccine production and diagnostic laboratory support. In addition, as part of the organizational structure, OCCGE and OCEAC would provide further regional expertise and coordination.

Working together in a collective effort, these various organizational components have over the past three years, successfully cooordinated and managed the regional resources and activities during Phase I; personnel working in one country have often been asked to contribute their knowledge and skills to programmes in other countries.

Technicians assigned to individual countries consisted of two types: medical epidemiological assistance to the countries and consultation in programme planning, came from positions of varying types, including private practice, teaching assignments, preventive medicine programmes, and in some instances, from other overseas positions. Operations officers came from several job areas but were primarily selected from the group of Public Health Advisers who had training and experience in the management of preventive medicine programmes in the United States. Their chief function was to assist in carrying out the operations of the programme and to provide consultation and advice in the areas of programme management.

In each country throughout the Project Area, similar health workers were selected and assigned full time to this new effort. In terms of manpower, project countries provided full time personnel for the programme at a ratio of more than thirty to one to US assigned technicians.

Training for the US technicians was provided at the NCDC in Atlanta, in the summer of 1966. As part of the specialized training, instruction was given in public health methods, the principles of smallpox eradication and measles control and the theories of programme management and operations. For those going to French-speaking areas, language training was necessary. During this period, training was also conducted in the project countries. After the arrival of the US technicians, further specialized training was provided to national workers in such topics as programme execution; operation and repair of the jet injector; clinical diagnosis of smallpox and measles; preparation, handling and storage of vaccine; vaccination site operations, publicity; assessment; surveillance; equipment repair; and other related aspects of campaign activities.

In the selection, procurement and allocation of commodities, every attempt was made to enable countries to determine the specific types of commodities required to meet their particular programme needs within the framework of the Project Agreements and the principles of regional standardization for commodities. Efforts were made to assure the continuing provision of necessary supplies and equipment but the inevitable and unforeseen eventualities, precluded a system without faults. The procurement Prob-

lem for this programme has often been administratively cumbersome. I'm told, some 15 different offices are involved in the procurement process. Shipping strikes create logistical difficulties of tremendous magnitude, and customs procedures in the countries often hold up the delivery of commodities for long periods. Sometimes necessary minor manufacturing modifications in equipment caused significant field problems when replacement parts in the field would no longer fit. Special efforts have constantly been made to provide emergency procurement and distribution, but all too often it has been the ingenuity of local personnel that has kept the campaigns going.

In addition to the resources provided by the project countries, more than $21,000,000 has been contributed by the United States in the first three years of the project. In some instances, in spite of high cost, certain commodities did not, and still do not, reflect the quality of construction which is needed for the adverse conditions which are encountered. Probably the most disheartening logistical situation has been the inability of this programme to yet resolve the equipment problems associated with maintaining the "cold chain".

Possible cost reductions have been, and are being, expolored constantly. Significant savings have been realized through changes in procurement and in programme tactics. An alternate source was found for jet injector parts which resulted in a $100,000 saving. More than $20,000 was saved by finding an alternative source for Ped-O-Jet cleaning kits. Hydraulic fluid for the Ped-O-Jet pumps was originally costing the programme $12 per pint but NCDC personnel determined that any good grade of transmission fluid would work: annual savings: more than $20,000. Different packaging techniques for vaccine, diluent and transfer needles resulted in another $30,000 savings annually. These examples represent only a part of the success realized in this particular area of operations.

Tactical changes in the programme have also resulted in tremendous savings. In the measles vaccination component, it was found that most children beyond 3 years of age had experienced measles, thus permitting a downward adjustment in the age limit of the target group. Work is in progress to determine which antigens can be simultaneously administered with safety and efficacy. The administration of multiple antigens with basically the same delivery system will greatly reduce the costs of preventive vaccination.

Several important considerations concerning commodities and their distribution should be carefully weighed in any future similar venture. Lead time, or that period between the request for a commodity and when it is delivered, has usually been much longer than anticipated even when all known factors have been considered. The production and delivery schedules furnished by the manufacturers have often been inaccurate. Additionally, there are unexpected delays such as change of production because of higher priorities, suppliers who are delinquent with goods to the manufacturer, labour disputes, etc. Very careful consideration should be given to the concepts of lead time vis a vis warehousing since it must be kept in mind that overstocking ties up valuable warehouse space, increases inventory which may not be needed later, and greatly contributes to the problems of inventory management.

A regional supply and management coordinator based within the Project Area, at the optimam communications point to the rest of the area has been demonstrated to be a vital component in the logistical system. With a master inventory listing from each country, updated monthly by data submitted to him, he can request by telegram the release of needed items from one country for use in another. While particularly effective as an emergency supply procedure which drastically cuts expensive priority procurement and air delivery from manufacturing sources outside the Project Area, the system can also be used to make routine adjustments in country inventories by sending overstocked items from one country to another.

In review of our operations, including the methods and tactics used, new epidemiological concepts have emerged and some older concepts have been validated.

Mass vaccination has been clearly demonstrated to still be the best method to increase rapidly the level of immunity in populations of developing countries. This can best be carried out in most instances through mobile teams using the jet injector and vaccinating at designated assembly points.

In a mass campaign, the emphasis should be on rapid delivery and a high rate of effective coverage. Campaigns should start in endemic or poorly vaccinated areas and then move across the country attempting saturation coverage by vaccinating individuals regardless of vaccination history. Special consideration should be given to vaccinate, as soon as feasible, along the borders of adjacent countries which have endemic smallpox. In addition, planning must be concerned with population movements, and the climatic conditions which affect road conditions as well as the rate of disease transmission.

Traditional population centres as locations for mass vaccination activities were widely used. The "collecting point" technique of having the vaccinees come to the vaccinators enables the teams to proceed at a faster pace, with fewer personnel and usually with better supervision than can be afforded by the village-to-village or house-to-house approach. On the other hand, vaccinating at collection points usually results in lower overall coverage and leaves residual pockets of susceptibles. In addition, the use of collecting points requires more comprehensive planning and advance notification in order to assure adequate turnout.

In many project countries, mobile teams, comprised of paramedical personnel, were already being used to provide health services in rural areas. In the administration of smallpox and measles vaccines, basically two types of teams were used: multi-purpose teams and special smallpox-measles teams.

Multipurpose teams generally operated at a much slower pace, providing fewer vaccinations, than did the special teams, because the multipurpose teams are involved with providing other health services. While adding vaccination responsibilities to these teams reduced administrative work and planning, and lessened the need for logistical support services, the slower pace of the teams often caused migrant populations to be missed, but, on the other hand, encouraged attendance of children.

When the programme began, the Ped-O-Jet was chosen for use by most of the countries because of its operational advantages, particularly in terms of accelerated coverage and the higher take rates made possible by a standardized simple technique. For those countries with limited financial resources for health services, and insufficient numbers of trained personnel, the Ped-O-Jet was particularly attractive because of the reductions which could be expected in costs through savings in personnel time.

The Ped-O-Jet was never intended to be the only instrument for vaccination. Indeed, in some instances it is clearly inappropriate. Multiple puncture by the bifurcated needle is usually the best method for vaccination of small groups, and in scattered or difficult to reach groups. Static centers with relatively few people to vaccinate at any given time have found the multiple puncture method more appropriate than the Ped-O-Jet.

Health information and education have been two very important aspects in the mass vaccination programme. The most effective methods of promoting health information and education have been through the existing political and traditional structures. Through personal visits of individuals to local leaders, the programme has achieved particularly successful results in terms of public awareness and population response. Posters have also been useful as an educational device to increase the communities' awareness to smallpox and measles and to announce the places and times of the vaccination teams. The portable loudspeaker has been particularly effective as a means for drawing crowds to assembly points.

A number of other methods of health information and education have been employed but themost important has been the sending of advance men ahead of the teams to contact personally local leaders and to participate with them in the selection and preparation of the vaccination assembly points and in the notification of the local population. These advance men may or may not be formally trained in health education and, in some instances, may not be from the health field.

Every effort should be made, as we enter the more sophisticated maintenance phase of this programme, to broaden the scope and range of health information and education activities.

The assessment of programme activities constitutes a vital part of the overall plan. Assessment procedures, including those of statistical sampling, provide an excellent means for determining programme effectiveness, and where mistakes in planning and execution have occurred, allow for their early detection. Unfortunately, the value of assessment has not been sufficiently realized by some of the project countries.

Assessment activities are generally conducted from three different, but related approaches: concurrent, periodic and terminal. In all three instances, assessment is best provided by individuals who are administratively independent of the vaccination teams.

Periodic and concurrent assessment enables a programme to evaluate team performance and techniques while the vaccination activities are in progress. In addition, it provides for a check on the scheduling of teams and on the work output of the teams. It permits the extent of coverage of the population to be determined, as well as the level of immunity in the population. It represents an ideal way to identify groups which have been missed by the vaccination teams, and in some instances, to determine why they were missed. Periodic assessment can indicate the need to reschedule teams, to allocate additional resources, and to correct programme deficiencies. In detecting smallpox cases it has also proved to be an effective surveillance tool.

Terminal assessment is used to determine how well the country-wide effort has been carried out. This type of assessment usually consists of a comprehensive evaluation of the country through procedures which include statistical sampling. Terminal assessments have been carried out in several countries. Information gained from these country assessments has contributed in a very important way to the evaluation of the entire project.

An effective surveillance mechanism which has an alert, country-wide reporting network, and which demonstrates the capability to undertake prompt investigative and containment measures is the most important element of any eradication or control programme In the development of a good surveillance system, it is necessary to make certain that there is routine reporting from every designated reporting centre, and that there are a sufficient number of these centres appropriately located to detect most smallpox outbreaks. Complete reporting becomes more significant as smallpox declines. Determining the percentage and frequency of participation by each reporting centre can best be done through a comparing of reports expected with received reports, and by an analysis of the information contained. In an efficient surveillance system, negative reporting should be just as dependable as the reporting of cases which occur. Programmes should always consider that it is better to have over-reporting of cases than to have cases missed because of a low index of suspicion.

When assistance is furnished to reporting centres to encourage better reporting, it can best be provided through personal visits and through the provision of "feedback" information; a very useful device but one that is frequently overlooked. Sierra Leone, with its monthly newsletter "The Eradicator", has clearly demonstrated one effective way of providing "feedback" information. Mali, Niger and Guinea are among those coun-

tries which have also planned, or have already implemented, newsletters as a means of providing information to reporting sources. There must also be provision for the notification of cases to neighbouring countries by telegram, and where official reporting procedures are slow, informal notification should be carried out.

Most of the countries have made special efforts to strengthen their reporting systems. Upper Volta, for example, carefully reviewed it surveillance procedures and developed and implemented changes to create a more effective reporting system. Togo has also improved its system by the addition of individuals who, in endemic areas, go from house to house searching for cases. In the last several months, more smallpox cases have been detected and reported by these individuals than through the routine reporting system.

In surveillance, outbreak control is equal in importance to the complete reporting of cases. As in reporting, the prompt containment of every outbreak becomes increasingly important as smallpox cases decline and population immunity increases. Because smallpox cases occur in localized groups, the number of outbreaks which occur becomes of greater epidemiological significance than the number of cases reported.

A smallpox outbreak is defined as one or more cases which are related, epidemiologically and in time, and which occur in a given geographic area. When an outbreak is reported, prompt comprehensive investigation and containment measures are essential. In most instances, outbreak control should be assigned higher priority than mass vaccination, at least to the point where the allocation of resources for outbreak control causes mass vaccination activities to halt completely.

Through the many investigations, programme personnel have substantiated the containment procedures which should be used when smallpox is reported.

First, outbreaks must be promptly investigated. The longer the period between the report and the investigation and outbreak control, the greater the possibility for disease transmission. Prompt investigation also encourages reporting for it indicates to the reporting centre that action is taken when reports are received. To achieve a prompt response, each country should have a mobile outbreak control team specially trained and ready for this purpose. When not needed for outbreak control, this team may be used for assessment activities or for vaccinating particular groups which could, because of location or composition, slow up the normal vaccination campaign.

Second, the diagnosis should always be confirmed by a qualified individual. When there is any doubt concerning the diagnosis, the suspect case should be handled as though it were smallpox. Clinical diagnosis becomes more difficult as cases become fewer which makes laboratory confirmation of smallpox cases at the later stage of the programme essential. The diagnostic laboratories in Lagos and Atlanta are both equipped to do tests on specimens submitted and at this stage specimens should be collected during all outbreak investigations.

Third, the extent of the outbreak should be defined. In the application of control techniques, it has been demonstrated that more investigation with selective control is more effective than less investigation and the indiscriminate application of control procedures.

In tracing the chain of transmission depends upon the frequency and intimacy of contact. While the patient, or his close friends or relatives, through questioning often know the source of the infection, active investigation should be instituted in the immediate area to detect other cases. The household, in most instances, is the basic epidemiological unit, with children playing the chief role in the transmission of smallpox as they move from one household to another. The probability of transmission appears also to be influenced by the infectiousness of the case. Transmission has been

shown to occur with greater frequency from a patient who was unvaccinated or who dies. The investigator must also keep in mind that smallpox develops slowly and has been known to exist for weeks before being detected by authorities.

Fourth, when cases are found they should be isolated if possible, although isolation of patients is usually accompanied by social and economic hardships for the family and friends. Only those individuals who have had smallpox or who have recently been vaccinated should be allowed to visit or attend the smallpox patient.

Fifth, vaccinations in the local area must be performed to halt the spread. The target group must be geographically and functionally defined, and this is where the results of careful investigation are realized.

Sixth, outbreak investigation forms should be prepared on every outbreak. As cases become fewer, information on the outbreaks becomes of greater significance. Age, sex and vaccination status as determined by scar identification should be obtained.

Finally, the notification of smallpox cases to neighbouring countries is necessary so that these countries can implement control measures.

In 1968, a new operational concept concerning smallpox eradication was introduced, "Eradication Escalation". Basically, eradication escalation is an intensified surveillance and containment programme which utilizes intensive case detection by all sources including individuals and groups outside of the official reporting channels, and prompt outbreak containment procedures both of which are employed particularly during the normal seasonal low of smallpox. When properly conducted in association with mass vaccination activities, there need be no significant decrease in the total vaccinations administered, although the programme has shown that in some cases some decrease in effective supervision may occur.

The mass vaccination campaign will soon be over in every country, and the sophisticated operations concerned with maintenance activities, which have already begun in some countries, will be under way throughout the Project Area. It is already apparent that mass vaccination techniques must continue as the most important part of maintenance activires. While the role of fixed centres should become increasingly more effective, it will be the mobile teams, administering vaccinations to susceptibles through appropriately rimed cycles, which will assure the continued high level of immunity. Adequate priority must be given to assessment activities to enable each programme to be certain that its plans are being effectively carried out and that target groups are being vaccinated sufficiently to prevent smallpox and to reduce measles morbidity. Efforts must be accelerated to provide a more complete surveillance system, alert to detect smallpox, and prompt in its containment response. Health education, to increase each community's awareness to the problems of smallpox and measles must be given greater emphasis, and efforts to gain understanding and participation on the part of health workers and the general population alike must be vigorously applied.

A review of the operations in the West and Central African Project Area affords us the opportunity to examine our successes as well as our failures. The methods and tactics which have proved valuable should be carefully considered in planning similar programmes

THE VALUE, EFFICIENCY, AND LIMITATIONS OF COLLECTING POINTS IN MASS VACCINATION PROGRAMMES

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INTRODUCTION

The Smallpox Eradication and Measles Control Programme (SMP) of Nigeria has been highly successful in operating a mass vaccination programme based on collecting points. In the six Northern States, a total of 18,275,653 smallpox vaccinations have been performed from July 1967 through February 1969. In the Southern States over 17,000,000 smallpox vaccinations have been performed during the same period. All of these programmes have used mass vaccination techniques based on collecting points rather than a door-to-door approach. In the six Northern States the teams have been able to vaccinate at a sustained rate of over 900,000 smallpox vaccination per month. This has been done with an average of 28 vaccination teams consisting of one team leader, five vaccinators and a driver. The average daily total of vaccinations performed by these teams is 2,869 for every day that they actually worked. The programme has been successful not only in vaccinating a large number of people; it has also achieved a high level of coverage. When the tally data are compared to the 1963 census, the coverage is about 95.9% (Table 1). Actual assessment performed by the ongoing assessment programme indicate a similar level of coverage (Table 2).

It is not possible to compare this method of vaccination directly with the multiple puncture method based on house-to-house or village-to-village visits as there has never been a large campaign based on these methods in Nigeria. However, it is reasonable to assume that the same number of vaccinators could not vaccinate this many people in a door-to-door campaign. Even in the Western and Mid-Western States, in areas where there are many small towns and villages, the teams have been able to vaccinate about 1,000 people daily.

TECHNIQUES EMPLOYED

The SMP in the six Northern States consists of a permanent field staff of 3 team supervisors and 28 team leaders who are trained and experienced in mass vaccination techniques using jet injectors. When the SMP is ready to start vaccination in a new state or province, an organizational meeting is held which outlines the objectives and needs of the programme. The local authority supplies the SMP with vaccinators who are trained by the permanent staff just prior to the actual campaign. The system of advance publicity used in the mass campaign is dependent upon the traditional rulers, who retain a great deal of their influence with their people. In general, the SMP arranges a schedule so that each district head is aware when the teams are to arrive. The team supervisor meets with the district head about one week before the programme is to begin to arrange vaccination sites that are about 10 miles apart. These vaccination sites are located in the best known and most influential villages. The district head then sends messengers to all the villages and hamlets to inform his people where and when they should come to get vaccinated. This publicity is arranged so that the villages are informed at least 24 hours prior to the arrival of the vaccination team. The team leader is given a list of villages and hamlets assigned to the vaccination site, so that the people from each village and hamlet can be checked off as they arrive.

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Assessment of the coverage achieved by the teams is done within two or three days on a spot check basis. In this way, areas that are poorly covered can be vaccinated prior to the time that the teams leave the area. In the Western State the teams try to visit all villages in the area, no matter how small. The villages are notified in advance when the team will arrive and a central collecting point is used when the team actually vaccinates. The programme is organized so that the teams may visit up to 7 of these small villages in a day. In the Mid-Western State a similar programme has been used, but in certain large villages of 1,000 to 4,000 it has been necessary to set up two or more mass vaccination points because the different political factions do not ordinarily mix, and the people from one section of a town will not cross to another section of the town.

FACTORS LIMITING THE EFFICIENCY OF THE MASS CAMPAIGN

Four factors are essential to the successful execution of a mass campaign based on collecting points: 1) Good advance publicity, 2) well organized teams and team schedules, 3) well motivated teams and 4) cooperation of the individuals being vaccinated. Most areas where the teams have failed to achieve very high levels of coverage can be related to one or more of these factors. Specific examples are useful in illustrating the importance of these points.

A. Urban Campaigns: The SMP in the six Northern States of Nigeria has consistently achieved only mediocre results in the execution of urban campaigns. The coverage in these campaigns has been consistently between 75%-85% while in urban campaigns in the southern states of Nigeria, coverage has been above 90% in some instances. The chief difference has been that the planning in the southern cities has started two to three months in advance, so that vaccination sites, publicity and health education can be well organized and coordinated. The highly successful campaigns in Lagos and Ibadan indicated that central collecting points had to be arranged so that there was at least one vaccination site per 8,000 population. The time which the vaccinations were performed had to be altered to coincide with the population availability. Due to the large number of people who were working during the day, vaccination sites were set up in the early morning and late afternoon. Factories and schools were vaccinated on a prearranged schedule.

B. Vaccination of Igala Division: The coverage that was achieved in the recent mass vaccination campaign in Igala Division, Kwara State was low for several reasons.

The area was markedly different from other areas in the six Northern States. The villagers are quite independent and relate poorly to the central authority. Therefore, the advance publicity was poor. Second, the area is quite disorganized due to the close proximity to the war front. This made the vaccination of certain areas impossible. Third, the team supervisor was relatively inexperienced and organized the teams poorly. At times they had no work to do, or the local authority had been informed too late to warn the people that the teams were coming. Mop up operations are being planned in this area. These plans will include the use of local personnel who are accustomed to working in the area as well as an advance publicity man who will educate the people during two separate visits to the village prior to the arrival of the vaccination teams.

C. Vaccination of Nomadic Groups: In areas where there are a large number of semi-nomadic and nomadic Fulani, the coverage achieved has been quite poor, even though the coverage among the sedentary population has been excellent. The problem in vaccinating nomadic people is that they are scattered in remote areas, making advance publicity of any sort extremely difficult. However, there is a basic difficulty that lies deeper than an inability to inform them they should come to be vaccinated. They are extremely individualistic and at times resistant to vaccination. Vaccination scar surveys have indicated that only about 40% of the nomadic Fulanis in western Sokoto Province had been vaccinated by the mass campaign at the

completion of the attack phase. Mopup operations in this area included a village-to-village and house-to-house campaign, using multiple puncture or Ped-O-Jet technique. This campaign was conducted during the rainy season when the Fulanis are in large camps. This facilitates their vaccination, but, even so, only about 80% were vaccinated. In general, mass vaccination based on large collecting points does not seem to be an effective way of vaccinating nomadic Fulanis.

A similar problem has been encountered in the rivers areas in the Southern States of Nigeria. As most of these villagers are involved in trading or fishing, 50% of the population is away from the village at any given time. As absence may be for days or weeks, advance notification has not been very effective. Therefore, the use of collecting points in this area has not been successful. Good vaccination coverage has been achieved by making repeated visits or by posting local staff in the area who can do a low intensity continuing campaign.

D. Vaccination of Migrant Labourers: There are large numbers of migrant labourers who travel hundreds of miles into small isolated farm camps in the southern States. As these people relate poorly to the central authority in the farming area, vaccination of this group must be directed to the dry season residence or to transport routes. A similar problem exists in the Northern States during the dry season, when a large number of workers travel to urban areas and areas in the south to look for work. In Kano City, transient persons enter and leave the city at a rate of about 20,000 per day. Vaccination of these people has been accomplished at mass vaccination points located along the main roads leading into town over a three to four week period of time.

E. Vaccination of the Small Remote Village: The mass campaign in the North has experienced difficulty in vaccinating small remote villages or hamlets that are located a great distance from the vaccination site. Actual assessment data has not shown a significant difference between the coverage which the programme has achieved in villages less than two miles from the vaccination site and those villages that are more than five miles from the vaccination site (Table 3). However, the SMP has investigated two important outbreaks of smallpox that have occurred in small remote poorly vaccinated villages. The failure to vaccinate such villages could be the result of either of two factors. First, the village might not have been notified that the mass campaign was being carried out; second, although having been notified, the villages may have been reluctant to walk the distance to the vaccination site. The first of these reasons is a failure in the advance publicity, and the second is a failure of the organization of the campaign.

F. Decreased Coverage of the More Recent Campaigns: There is good evidence that the mass campaign in the six Northern States has been doing a less efficient job as the campaign goes on. Coverage achieved in sample area I of the Bauchi campaign was less than 80% in a population of more than one million people (Table 4). This is compared to a coverage of over 90% that was achieved earlier in the programmes in Sokoto, and Katsina and Kano. This is probably due to a decreasing interest on the part of the team leaders and team supervisors. When the mass campaign was first initiated, they had a great deal of interest and enthusiasm in their work. However, as the campaign has progressed, the interest has definitely decreased, especially since the formation of the six new Northern States and the consequent interest of team leaders to be reassigned to their home States.

G. Poor Coverage in Highly Individualistic Animinist Villages in the North-Eastern State: Even if the mass campaign is functioning efficiently, the teams must have the cooperation of the people. In Adamawa Province there is a tribe of highly individualistic villagers who are quite resistant to vaccination. Preliminary assessment results indicate that the coverage in this tribe was only about 62% while the coverage in other villages in the area was over 90%. The lack of cooperation in these areas will be extremely difficult to overcome, requiring a well-

organized health education project that is able to reach large numbers of people and convince them of the value of vaccination.

SMALLPOX IN VACCINATED AREAS

One of the best ways of evaluating collecting points as a means of operating a mass vaccination campaign is to examine the various smallpox outbreaks that have occurred in vaccinated areas. These outbreaks fall roughly into five categories: 1) smallpox occurring in isolated compounds and small isolated hamlets, 2) smallpox occurring as small outbreaks or isolated cases where the coverage has been moderately good, 3) smallpox occurring in nomadic groups, 4) smallpox occurring as single importations into well vaccinated villages and 5) smallpox occurring in vaccinated individuals.

1. Smallpox in remote villages and isolated compounds: As discussed previously, remote villages that are unvaccinated have been responsible for at least two major outbreaks in vaccinated areas. The importance of these isolated pockets of susceptibles depends on the extent to which they exist. If a large number of these hamlets are left in vaccinated areas, it is possible that they could support smallpox transmission for long periods of time.

2. Smallpox occurring in villages where the coverage has been moderately good: There have been several outbreaks, particularly in Kano State, where up to seven cases of smallpox have occurred in villages where coverage is between 60 to 80%. It appears that these villages have been poorly covered for reasons discussed. However, smallpox transmission appears to be a limited phenomena with, at most, 2 to 3 generations occurring in any one village. This is enough to permit transmission, as these cases, in turn, appear to be responsible for the introduction of the disease into other villages with a limited number of susceptibles.

3. Smallpox occurring in migrant groups: A series of smallpox outbreaks in Western Sokoto province of the North-Western State occurred during the first half of 1968 and appears to have been related to smallpox transmission that was supported by nomadic Fulanis who had not been vaccinated by the mass campaign.

   A number of smallpox cases have been exported from outbreaks occurring in migrant workers, particularly in the cocoa plantations around Oyo in the Western State.

4. Smallpox occurring as single importations into well vaccinated villages: There have been a total of eight confirmed importations of smallpox into Katsina Province of the North-Central State since the completion of the mass campaign. In none of these cases has there been any transmission within the villages. All of these villages had an extremely high level of immunity which did not permit continued transmission of smallpox.

5. Smallpox occurring in vaccinated individuals: There have been about 14 cases of smallpox in individuals who have stated that they have been vaccinated by the SMP. All but four of these occurred as isolated cases, while the others all occurred in one compound that went through the vaccination line at the same time. It seems likely that most of these cases were due to poor technique on the part of the vaccinator.

SUMMARY

Vaccination at collecting points has been very successful in the SMP in Nigeria. In the six Northern States the mass campaign has been able to use collecting points located about 10 miles apart and to achieve a coverage of 90% in areas where the traditional authority is quite strong. In the Southern States the vaccination sites have had to be organized on a village to village basis, but collecting points have been successful in vaccinating the people once the team is in the village. Critical to the

success of a mass campaign based on collecting points are four factors: 1) good advance publicity, 2) well organized teams and teams schedules, 3) well motivated teams and 4) cooperation of the people being vaccinated.

Table 1. Percent Vaccination Coverage Estimated by Comparing Tally Data with Population Data

State	Province	Population 1963 Census	No. of Smallpox Vaccinations (Tally Data)	Population Vaccinated (%)
North-Western	Sokoto	4,334,769	4,183,464	95.3
North-Central	Katsina	2,545,005	2,749,824	100+
Kano	Kano	5,774,842	5,560,571	96.1
North-East	Bornu	2,854,000	2,576,575	90.3
North-East	Bauchi	2,476,329	2,347,233	94.6
Total		17,984,945	17,407,667	96.7

Table 2. Percent Vaccinations Coverage by Age in Sokoto and Katsina Provinces and Kano State from Assessment Data

	Age Group			
	0-3 yrs.	4-14 yrs.	15+ yrs.	Total*
Sokoto	96.7	97.3	95.7	96.3
Katsina	96.7	96.5	92.7	94.4
Kano	89.1	93.8	88.8	90.6
Total*	93.1	95.5	91.8	93.2

* Totals weighted in proportion to the population of each area.

Table 3. Percent Vaccination Coverage in Kano State by Distance from the Vaccination Site

Distance from Vaccination Site (miles)	Age Group				
	0-3 yrs.	4-14 yrs.	Male 15+ yrs.	Female 15+ yrs.	Total
0-1	91.5	96.6	91.5	90.4	93.0
2-4	91.2	94.3	92.4	88.7	91.7
5+	90.6	91.4	89.9	87.0	

Table 4. Percent Vaccination Coverage for Assessment Sample Area No. 1 in Bauchi Province

Age	Male	Female	Total
0-3 yrs	-	-	84.1
4-14 yrs.	83.8	81.9	82.9
15+ yrs.	66.2	81.5	73.8
Total	-	-	78.5

COMPARATIVE ADVANTAGES OF JET INJECTORS AND BIFURCATED NEEDLES

G. F. Glokpor[1]

I should like to describe first our experiences in Togo in which, during the last quarter of 1968, we employed teams which used the multiple puncture vaccination technique. I should then like to contrast the advantages of the use of these needles in a house-to-house campaign with the use of jet injectors under different circumstances.

EXPERIENCE WITH BICYCLE VACCINATION TEAMS IN TOGO

One of the most instructive experiments carried out in 1968 involved the use of vaccination teams equipped with bicycles. It was carried out partly with the staff of the National Malaria Service, and partly by the mobile personnel of the public health subdivisions of Anécho and Tabligo.

The National Malaria Service has a well-organized staff trained for work in the field, and includes sprayers (auxiliaries), team leaders, sector heads and supervisors. Thirty members of this Service (formerly sprayers), each equipped with a bicycle, were divided into six teams and placed under the control of the sector heads. Each group of three teams was placed under the supervision of a male nurse or a hygiene assistant who was provided with a car. Each team was allocated a precisely defined geographical sector which it was required to cover by bicycle, farm by farm and house by house, in order to vaccinate the population and at the same time to carry out an active search for cases of smallpox. Vaccination was performed by the multiple puncture method using bifurcated needles.

The second group employed were mobile personnel who are auxiliaries attached to the basic health services and who are normally responsible for visiting once a month every house in a given sector. They were trained as vaccinators and made responsible for the same work as the malaria control personnel. However, they operated individually in the area covered by a dispensary. There were 15 such auxiliaries for the public health subdivision of Anécho and 5 for that of Tabligbo.

The vaccinations performed by the various teams during the last quarter of the year were as follows;

Month	Regular teams (jet injector)	Malaria teams (MP)	Mobile personnel in Anécho (MP)	Total
October	50,975	-	39,404	90,379
November	25,208	32,759	18,530	76,497
December	61,052	42,407	24,656	128,115
Total	137,235	75,166	82,590	294,991

The work of such teams cannot be judged solely on the basis of the number of vaccinations performed as the method used was not such as to make possible the rapid vaccination of a large number. In addition, it was often necessary to travel great distances in order to vaccinate perhaps ten persons only.

Previously, vaccination campaigns had been carried out by gathering people together at selected collecting places (schools, health centres or posts, markets, etc.) to which the teams were transported by motor vehicle. In larger towns, several assembly points were used while in small centres, a single assembly point. The assembly points

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were chosen so that the population did not have to travel far. The advantage of this system was the rapidity with which the campaign could be carried out, still further increased by the use of the jet-injectors. In a country like Togo, however, all population centres are not served by roads suitable for vehicles, so that the teams necessarily travelled only to the accessible places. The consequence of this method is that the population of larger centres is generally well covered while farms and hamlets are either inadequately vaccinated or not vaccinated at all. Investigations of cases of smallpox in Togo revealed that it was precisely in these small communities in which smallpox transmission was being maintained. The bicycle teams have the advantage of being able to reach places inaccessible to the regular mobile teams and are able to visit every house in farms and hamlets. The use of such teams is well adapted to vaccination in the southern region of Togo where the population is dispersed among many small farms which, although isolated, are always linked together by tracks suitable for bicycles. In addition, these teams can vaccinate on the road persons who have left their houses to go to the fields or to market. Above all, they can reach young children and old people who have stayed behind in the village or farm.

These teams require only auxiliary personnel with no particular qualifications. They are, therefore, inexpensive. It is essential, however, that these personnel be well organized and kept under constant, close supervision. This was easily achieved with the malaria control teams, with their supervisors.

EFFECTIVENESS OF THE TWO METHODS UNDER DIFFERENT CONDITIONS

1. For what type of population centre are the two methods suitable?

In a vaccination campaign employing teams equipped with jet injectors, large centre are generally adequately vaccinated and small centres are poorly vaccinated or not vaccinated at all. The same applies to localities not accessible by roads. Thus, vaccination with the jet injectors is most suitable for towns and large villages, schools, markets, etc. For vaccination in small villages, farms, hamlets and in localities which are difficult of access, the multiple puncture method appears to be more effective. This method also makes it possible to reach the newborns and children up to the age of four, as well as old people, age groups which are often inadequately vaccinated by the jet injector teams because they remain in the village when the parents are in the fields or at the market. For persons who resist vaccination, a vaccinator who uses the multiple puncture method can try to convince such persons individually. On the other hand, there are situations where the jet injector has a psychological advantage over the multiple puncture method. In Togo, for example, during a campaign carried out between 1962-1966, a vaccine was used in the later stages which gave very severe reactions. This has not been forgotten by the population of certain areas. This vaccination was effected by means of scarification with vaccinostyles. Since the needles used in the multiple puncture method remind the population of the last campaign, it is preferable, under these conditions, to use the jet injector.

Lastly, vaccinators using the multiple puncture method, as I have described, are able to do case finding as they move from house to house. I should also add, that vaccination by the multiple puncture method is particularly suitable for a maintenance programme in which vaccination is performed by mobile personnel and in fixed public health units.

2. Requirements for advance publicity

Vaccination by jet injector, if it is not to lose its advantage of speed, requires use of the collecting point system. Fairly precise planning of the campaign is therefore necessary, since the population must know on what day and at which place it must assemble. It is thus necessary to send a team to the places concerned, so

as to hold meetings with responsible persons to plan the campaign. In addition, the vaccination team must be preceded by a health education team, all of which adds to the cost. In contrast, vaccination on a house by house basis which does not involve assembly of the population requires a less precise degree of planning. Each team is simply assigned a particular geographical area and, in the course of their work, they may carry out health education.

3. Effectiveness of the two methods in terms of the take rate

The two methods give comparable take rates. Nevertheless, a defect in the jet injector which is not rapidly detected may result in a number of unsuccessful vaccinations. On the other hand, vaccination by the multiple puncture method may be rendered ineffective if products are applied by the vaccinee to the site of vaccination.

4. Logistic factors

Vaccination by the multiple puncture method is easier to teach than vaccination by means of the jet injector. This makes it possible to employ temporary personnel and volunteers in a vaccination programme. In a maintenance programme, all male nurses of the public health units can easily be trained in vaccination.

In a vaccination campaign using the jet injector, at least one member of the team must be capable of tracing faults and carrying out simple repairs. When needles are used, breakdowns are impossible; the only problem is that of sterilization, but this is easily solved by providing every vaccinator with a small bowl for the purpose of sterilizing the needles by boiling (every farm has a fire). In our trials with the malaria control personnel, the supervisor collected the used needles each day and had them sterilized at the health centre, while for the mobile personnel, we adopted the method of using small bowls for sterilization.

CONCLUSIONS

I may have given the impression of being an advocate of the multiple puncture method, but I should like to conclude by saying that one method is not in itself or in absolute terms better than the other. It depends entirely on the circumstances.

Thanks to the jet injector, hundreds of thousands of vaccinations have been effected rapidly. In the case of a smallpox epidemic in a town or other large population centre, the jet injector enables the situation to be brought rapidly under control. The two methods can even be used to complement each other to advantage, as was done in one of our districts, in which the jet injectors teams carried out vaccination in the large population centres and such villages as were accessible, while the mobile bicycle teams took to the paths to perform vaccinations in the farms and scattered villages. In addition, after a vaccination campaign with the jet injector, the areas can be gone over again by multiple puncture teams in order to try to reach the few who have escaped vaccination, especially the newborns and children up to the age of four. This is particularly desirable when assessment has shown that vaccination coverage in a given area has not reached a satisfactory level.

It is essential, therefore, in a programme, not to give preference to one method or the other but to achieve the maximum coverage, but the use of the method appropriate to the circumstances.

ADVANTAGES AND DISADVANTAGES OF SPECIALIZED AND MULTI-PURPOSE MEDICAL TEAMS

J. M. Roux[1]

We have not had a great deal of experience in Chad in the operation of specialized teams concerned solely with the implementation of the smallpox and measles eradication programme. No such units exist, in fact, because such activities form an integral part, in all sectors, of duties performed by the multi-purpose medical teams.

Multi-purpose teams have been traditional in Chad. They were first introduced in 1946. According to an order published in January 1953, these units were charged with the responsibility for "improving the control of ... epidemics: cerebrospinal meningitis, smallpox, etc." The standard composition of such a team is as follows:

1. A team leader, who is responsible for supervision of the overall operations of the team and for making contact with local authorities on arrival at the site where vaccination is to be performed.

2. A secretary, who is responsible for preparing, for each person, a certificate bearing that person's name. This certificate must be produced and initialled whenever any procedure is carried out.

3. Four vaccinators.

   a) The first performs smallpox vaccination by jet injection
   b) The second performs BCG vaccination by jet injection
   c) The third performs measles vaccination by jet injection
   d) The fourth performs vaccination against yellow fever by means of a vaccinostyle, using the dried vaccine of the Pasteur Institute at Dakar.

Although vaccination constitutes the primary activity of such a team, the team also includes:

4. A person responsible for the detection of leprosy and trypanosomiasis.

5. Laboratory personnel capable of carrying out simple routine examinations (blood, feces, urine and cerebrospinal fluid examination).

6. Personnel responsible for treatment of the clinical manifestations of the most frequently encountered endemic diseases. The total staff normally consists of 12 male nurses, two drivers and two labourers.

The itinerary of the team is worked out in advance and communicated to the authorities early enough for the information to reach the lowest levels of the administration, who are responsible for alerting the population.

In contrast, the typical specialized team would normally consist of 4 or 5 persons.

1. A team leader, whose duties are the same as in a multi-purpose team;

2. One or two vaccinators to administer vaccine by jet injection;

3. A secretary;

4. A driver, who may possibly perform various other duties (police, helping the secretary, etc.).

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ACTIVITIES OF THE MULTI-PUPOSE TEAMS IN CHAD

I should like first to discuss the results achieved over a number of years by the multi-pupose teams, for which, incidentally, smallpox vaccination has been an integral part of their activities since 1952 (Table 1). Between 1 January 1966 and 28 February 1969, a total of 3,944,868 smallpox vaccinations were given. This figure is actually greater than that estimated by the census - 3,115,860 inhabitants. Although comparison of these figures would suggest that total coverage had been achieved, this actually is not the case.

Unfortunately, there is a central zone constituting a kind of corridor extending from Libya in the north to the frontier of the Central African Republic in the south-east in which a very large proportion of the population has not been immunized. This was not a result of defective operations on the part of the teams but due to other causes which resulted in the cessation of all activities in these regions at the beginning of 1967. However, limited activities have recommenced in these prefectures beginning in February 1969.

Wherever activities can be conducted normally, very satisfactory coverage has been achieved. It is practically complete in south-west Chad, where the population density is greatest.

Coverage with respect to measles vaccination bas similarly been good, if it is considered that 24% of the total population consists of children between six months and six years of age (Table 2). As may be seen from the table, several areas were poorly covered for the same reasons noted previously. Take rates in primary vaccinees have consistently exceeded 95% (Table 3) and in revaccinees, the take rates have never been less than 55%.

From these data it is clear that the smallpox and measles vaccination programmes have been successfully carried out by the mobile multi-purpose teams.

This integration has been greatly facilitated by the use of the jet injector, which has markedly increased the output of the vaccinators, while enabling their number to be reduced, thus freeing personnel for other duties.

DISCUSSION

There are several advantages in using the multi-purpose teams in Chad:

1. The teams are well known, having been in action continuously since 1946.

2. The personnel are well trained. After they have left the National School of Nursing, they are given practical in-service training in the field and theoretical instruction so as to be able to perform any duty in the team. Thus a male nurse can change over without difficulty from the detection of trypanosomiasis to performance of vaccination.

3. By combining several functions, there is a decided saving in the number of vehicles required as well as fuel and spare parts. Additionally, fewer refrigerators are necessary, and since they are gas operated, their operational costs are also reduced.

4. With fewer teams, the required number of drivers is reduced. This is important both from the standpoint of funds but also because good driver-mechanics in Chad are difficult to find.

5. The existence, as a part of the team, of a treatment unit constitutes an important psychological factor in improving attendance.

On the other hand, smaller specialized teams would have greater mobility and would be more highly flexible. Their establishment, however, would give rise to a dispersion of both personnel and equipment such that, under the present circumstances, we would have to make a painful choice as to which of the present activities would need to be curtailed. Additionally, repeated summonses to villagers to attend for examination would almost certainly reduce the proportion of attendances.

CONCLUSIONS

In our view, the choice between multi-purposes and specialized teams must depend on:

1. Geographical characteristics of the state concerned (difficulty of surface communications, population density, type of habitat);

2. Facilities and availability for training of adequately qualified personnel;

3. Equipment, especially vehicles, and funds locally available;

4. Type of structure of the general health services in the country in which the eradication campaign is to be carried out.

In this connection, two cases may be considered:

a) If no mobile services exist in a state, but only fixed health services, there are grounds for establishing small specialized teams for the eradication campaign;

b) If there are specialized mobile teams, such as the Service des Grandes Endemies, for example, it would be preferable for the eradication operations to be integrated with this agency. The operations can actually be facilitated without interruption existing services, as the example of Chad has shown.

Should an outbreak occur, however, it should be possible for a specialized team to be established quickly so as to take effective containment measures.

Thus, wherever possible, the two systems should not be regarded as alternatives, but each should complement the other.

Table 1. Smallpox Vaccinations, Cases, Deaths - Chad - 1952-1966

Year	No. of Vaccinations	Cases	Deaths	Imported from
1952	313,947	2,789	609	
1953	376,349	680	226	
1954	671,485	518	112	
1955	941,638	259	55	
1956	709,686	51	2	
1957	539,457	54	3	
1958	938,034	15	0	
1959	516,479	17	1	
1960	643,953	2	0	
1961	810,641	502	62	Nigeria
1962	758,977	769	150	Cameroon
1963	593,922	10	1	
1964	559,974	5	2	
1965	1,089,406	73	10	Nigeria
1966	1,008,489	0	0	
Beginning of Eradication Campaign				
1967	1,386,215	86	23	Nigeria
1968	1,345,412	5	1	Nigeria

Table 2. Total Vaccinations - Measles and Smallpox
January 1966-February 1969 Chad

Division	Population 1969 (by Census)	No. Smallpox Vaccinations	No. Measles Vaccinations
Chari Baguirmi	357,511	930,553	118,496
Mayo Kebbi	446,404	768,554	165,347
Tandjile	251,222	176,540	52,450
Logone Occidental	232,055	303,075	73,571
Logone Oriental	257,077	318,746	68,790
Moyen Chari	384,692	666,768	122,646
Salamat	67,675	24,968	34,187
Guera	171,571	79,122	26,641
Batha	260,336	131,097	23,674
Kanem	161,381	135,361	11,323
Lac	94,949	99,386	17,783
Ouaddai	248,385	178,462	6,539
Biltine	114,525	107,079	4,716
B.E.T.	68,077	25,157	3,766
TOTAL	3,115,860	3,944,868	729,929

Table 3. Vaccination Take Rates
March - September 1968

Age Group	Primary Vaccinations Number	Percent Takes	Revaccinations Number	Percent Takes
0-4	454	97.8	582	74.9
5-14	95	92.6	1,259	57.9
15-45	37	81.0	2,425	49.2
45+	11	100.0	321	48.2
Total	597	95.9	4,587	54.8

SAFETY, EFFICACY AND PRIORITIES IN MULTIPLE ANTIGEN USAGE

R. C. Hendrickse[1]

INTRODUCTION

Alleviation of present morbidity and mortality rates in childhood in Africa will, to a large extent, depend on the social and economical advancement of the peoples of the continent. Even under existing conditions however, much can be done to improve the present dreary picture. The most pressing needs of infants and children include improved nutrition, improved environmental sanitation, malaria control and immunisation against the common specific infections.

Much effort has been directed at alleviating these needs by International and National agencies in recent years, but progress has been slow because of the magnitude and complexity of the overall problems involved. The area in which there appears to be reasonable hope for a significant break through is in the field of immunisation against common specific infections. This is so because(a) there are a host of effective immunising agents available at costs which are reasonable, (b) techniques for mass immunisation have been developed and tried and have proved satisfactory, and (c) evidence has accumulated to show that several antigens can be simultaneously administered without risk to the recipient, or loss of effectiveness of the individual constitutions.

It is this last consideration which I wish briefly to discuss as it has immense importance in the planning and execution of immunisation campaigns in developing countries.

THE IMPORTANCE OF "CONCENTRATING" IMMUNISATION PROCEDURES FROM THE PUBLIC STAND-POINT

In many tropical countries women are essential contributors in kind or cash to the family economy, and pregnancy, childbirth, and lactation cannot be permitted to interfere unduly with this role. This fact has important implications for those organizing immunisation programmes. If attendance is required too often or the time spent at each visit is too long, repercussions on the family economy often lead to the mother defaulting from further attendance. If to this is added the fact that in many countries disease prevention is regarded as a divine rather than a human function, the difficulties which might be encountered in trying to ensure attendance at Immunisation Centres will become apparent.

Unsanitary surroundings, overcrowding and relatively low standards of personal hygiene favour a high attack rate of communicable diseases among the very young. In many tropical countries, diseases such as measles, poliomyelitis, whooping-cough, and diphtheria occur almost exclusively in the pre-school child with an alarming emphasis in the first two years of life, while tuberculosis represents a perennial scourge from which no age is immune.

All these facts dictate that immunisation procedures should be carried out as early as possible and that in designing courses of immunisation the number of attendances required should be reduced to the minimum. The scope of the programme and methods employed will be determined by financial resources and the staff available.

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It has been standard practice for many years past to offer combined tetanus, pertussis and diphtheria immunisation to infants. The only risk associated with this procedure has been the occasional occurrence of an encephalitic reaction attributable to the pertussis component of the combined antigens. In as far as this risk has not been shown to be greater when pertussis antigen is given in combination with tetanus and diphtheria antigens than when pertussis antigen is given alone, it cannot be used as an argument against the combined antigen administration.

In more recent years, poliomyelitis vaccine either the live, oral, Sabin vaccine or the killed Salk vaccine, has been simultaneously administered with the triple antigen referred to above, and this quadruple antigen mixture has been shown to be safe and effective. The combination of these antigens has permitted the effective immunisation of infants against four important diseases, in the same time, at little extra cost and with little, if any, increased effort, than is required to achieve immunisation against any one of these diseases.

Recent experience with combined measles-smallpox immunisation on a large scale has furnished clear evidence that the combined vaccination is acceptable and effective and entails no greater risks than when either vaccine is administered singly. There is evidence also to show that Yellow Fever vaccine can be safely and effectively combined with smallpox and measles vaccine but this combination has as yet not been used on a very wide scale (W.H.O. 1963).

In as far as immunisation against Pertussis, Poliomyelitis, Tetanus and Diphtheria is preferentially completed within the first 4 to 6 months of life, while Measles, Smallpox and Yellow Fever immunisation are preferentially delayed until 6 months of life or a little later, there has been no practical need to explore the simultaneous administration of the former group of antigens with the latter group. It should be noted however that in endemic smallpox areas, it bas been found safe and satisfactory to combine smallpox vaccination with Pertussis, Diphtheria, Tetanus and Poliomyelitis immunisation, during the first 6 months of life. The usual practice being to administer smallpox vaccination simultaneously with the last dose of the quadruple antigens.

B.C.G. vaccination is being widely practised in many countries in Africa. In an ever increasing number of centres, immunisation is being offered during the neonatal period while the baby is still in the care of the Midwife or Obstetrician. This appears to be an entirely satisfactory and acceptable time for B.C.G. vaccination and if widely used will ensure that all infants born in hospitals and midwifery centres are immunised. In view of the ever increasing popularity of maternity homes in developing Africa, it would seem that B.C.G. innoculation in the neonatal period will ensure the maximum coverage of new susceptibles in the community.

Should an infant not have had B.C.G. in the neonatal period, this fact can be ascertained at the first attendance at an immunising centre and B.C.G. can then be given simultaneously with the first immunising dose of triple antigen and polio vaccine.

PRIORITIES

There can be little doubt that in Africa at the present time, tuberculosis, measles, tetanus and whooping cough represent the four major infectious diseases in childhood for which vaccines are available, which require urgent control if childhood mortality is to be effectively reduced. In as far as tetanus and pertussis vaccination can easily be combined with immunisation against diphtheria and in as far as this disease is a serious potential hazard it would seem logical to offer combined tetanus/diphtheria/pertussis immunisation to all infants. Poliomyelitis, though seldom a killing disease, is very prevalent and leads to permanent disability in many thousands of children annually and immunisation against this disease should be added to the triple antigen.

The arguments for Smallpox and Measles immunisation are too well known to be enlarged upon at this point and Tuberculosis control, representing as it does one of the most pressing needs in developing countries, demands the use of B.C.G.

Ideally every child born should be offered the following programme of immunization.

1. B.C.G. in the first week of life.

2. Triple antigen (Diphtheria/Pertussis/Tetanus) and Polio vaccine, three doses at monthly intervals, commencing at 6 weeks to 2 months of age.

3. Combined Measles and Smallpox vaccination at 8 months of age.

This programme of immunisation will entail only 4 visits after discharge from the Maternity Centre where the baby was born. For children not born in a Maternity Centre, and hence not given B.C.G., the vaccine could be administered on first attendance at the immunising centre along with the triple antigen and polio vaccine.

In areas where measles vaccination might not be feasible and where attendance for smallpox vaccination at 8 months cannot be relied upon, smallpox vaccination can be carried out at the same time as the last dose of triple antigen is administered, thus reducing the total number of immunising sessions to 3.

Where governments cannot undertake a full programme of immunisation because of limited resources, priorities will have to be decided in the light of local experience, national objectives and international responsibilities. In my view B.C.G. innoculation and Smallpox immunisation should be the first priorities of all governments, as Tuberculosis and Smallpox affect all age groups and are easily disseminated - and in the case of Tuberculosis - persistently disseminated. Tetanus is another disease which may affect any age group, but unlike the two previously mentioned, Tetanus is dangerous only to the patient with the disease and is not disseminated by contact. There is thus not the same public health problem as with Smallpox and Tuberculosis but in view of the widespread occurrence of Tetanus and the high mortality associated with the disease, plus the fact that immunity cannot be naturally acquired - I consider immunization against this disease as a priority in present day Africa.

In the child population, my experience leads me to believe that measles and poliomyelitis represent top priorities in immunization programmes for young children. There is evidence also to place whooping-cough on the priority list and in as far as this immunisation is usually combined with Tetanus, it would seem wise to recommend that Tetanus immunisation in the young should be combined with whooping-cough.

If asked to choose one vaccine besides Smallpox and B.C.G. - I would in the present West African situation opt for measles vaccine in poorly nourished communities and Polio vaccine in well nourished communities. This preference is based on observations that morbidity and mortality from measles are much worse in poorly nourished than well nourished children (Morley et al, 1967, Hendrickse, 1967) while the consequences of poliomyelitis seem to be unrelated to the nutritional status of the victim.

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ASSOCIATED VACCINE CAMPAIGNS
ORGANIZATION AND LOGISTICS

R. Labusquiére[1]

I. INTRODUCTION

Vaccination is probably the most efficient activity of services dealing with the prevention and control of contagious illnesses. However, because of the expenses involved in the operation of vaccination teams, it is necessary, in order to be truly efficient, to administer simultaneously multiple vaccinations. It is thus possible to vaccinate a maximum number of people against a maximum number of illnesses in a single visit.

Unfortunately, all vaccines may not be used simultaneously due to certain effects of interference, proved or suspected, and we must proceed with care. Even when the simultaneous inoculation of two vaccines in the same or different parts of the body is not dangerous, the price of the products may be too high to risk "wasting" a vaccine as a result of interference in immunity induced by either of the vaccines. Furthermore, the false security provided by vaccination with products which are thus rendered partially ineffective would constitute a serious danger.

Before examining vaccination policies which OCEAC has been trying to implement for the past few years, let us agree on the exact meaning of certain terms:

> Combined vaccination is the injection of a mixture of vaccines at a single site.
> Simultaneous vaccination is the injection of two or more vaccines at different sites.
> The term "associated" refers to both combined and simultaneous vaccination.

Vaccination programmes may extend over varying periods of time. We shall speak of two-year or three-year plans depending on the period covered. However, for a given location, the coverage cycle shall be called six-monthly, yearly, two-yearly or three-yearly, depending on whether the team will visit the location every six months, every year, every two years or every three years.

II. VACCINATION POLICY IN OCEAC

The policy outlined is a general policy which may be changed in response to local or temporal epidemiological circumstances, to financial conditions and to other factors. It covers most parts of a country, primarily the rural areas.

Polyvalent Teams

While we recognize the advantages of specialized teams which can rapidly conduct a specific campaign, we prefer to have polyvalent teams which proceed more slowly and deal with a number of disease problems at the same time. Vaccinations are most important, but there are other activities which must not be forgotten. It has been noted that the population response is much greater when the visit by the team is accompanied by vaccination and sanctioned by the delivery of vaccination certificates. Moreover, since it is difficult to achieve a good response from the population every two years, we should take full advantage of each visit to do all that can be done. None of the countries we are dealing with have at their disposal funds exceeding their needs, and it is much more economical to do a number of things at one time than to have

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to return to the same place several times. By this means, the same equipment, the same staff, the same fuel will be used only once and the limited funds available will not be used for a single special campaign to the disadvantage of other activities.

Vaccination Certificates

We believe that the delivery of personal vaccination certificates is essential, even though the cost of such a certificate may be significant and its delivery time-consuming. The certificate is generally carefully kept and the issuance of a certificate not only attracts people but also helps to prevent unnecessary vaccination of children who have already been vaccinated. Additionally, mistaken conclusions regarding the ineffectiveness of a given vaccine may be avoided, since very often people claim to have been vaccinated against a given disease when in fact they have been vaccinated against another. With the increased use of Ped-O-Jets, all vaccinations resemble each other in the eyes of the villager. This problem may be partially solved by administering vaccines at specific sites, i.e. left arm, right arm, left fore-arm, etc.

Pooling of Equipment

Vaccines and equipment are usually obtained through different sources. Some are bought by the government and others offered by various organizations such as USAID, FAC, UNICEF, etc. However, pooling of all available equipment must be an absolute principle. It must be possible, for example, to preserve the 17/D yellow fever vaccine in refrigerators provided primarily for measles vaccine and to have it injected by a team transported in vehicles provided by FAC along with other vaccines obtained from other sources.

Preference for Simultaneous Vaccinations

On the basis of the conclusions arrived at by the 1967 OCEAC Technical Conference, it appears that two simultaneous vaccinations are preferable to one combined vaccination so long as we do not have the vaccines already mixed in a single multi-dose bottle.

Frequency of Visits

Each country must decide on its own cycle of visits depending on the funds available, the number of its inhabitants, the number of mobile teams, the area of the districts, the ease of communications, the laws prevailing in the country and on local permanent or temporary circumstances. The frequency of visits may be fixed for the country as a whole, or different frequencies may be chosen for different parts of the territory.

For a number of years now, OCEAC has formulated schedules for yearly, two-yearly, and three-yearly cycles. Each has its advantages and its disadvantages. For various reasons, particularly for ease of implementation and for the coverage provided, the two-yearly cycle appears to us to be the best. It is of this cycle, therefore, that I shall speak in greater detail.

III. ORGANIZATION OF A VACCINATION CAMPAIGN

It is relatively easy to give vaccinations, particularly with jet inejctors, and there is no need for "specialists" who only perform vaccination. Knowledge of how to preserve vaccines, of how to maintain and repair the equipment and how to inject the vaccines is important, however. Equipment necessary for this purpose is as follows:

Cold Chain

At the district centre, the following equipment must be available:
A freezer where dry vaccines requiring storage of -10°C to -20°C can be stocked, and a refrigerator for those vaccines that must be kept at +4°C.

a freezer or portable refrigerator, preferably gas-operated, to be transported in the vehicles used by each team for the transport and conservation of vaccines and the refrigeration of ice-boxes.

one or two isothermic chests to carry vaccine when the vehicle containing the freezer is not nearby, or when it is necessary to put the vaccine temporarily in a cold place during an interruption in vaccination procedures.

Any district which does not have this equipment or any team which is unable to renew its ice-boxes daily must not undertake vaccination campaigns, except for smallpox and BCG campaigns, for which vaccines are more stable than, for example, measles or yellow fever vaccine.

Ped-O-Jet

Small series of vaccinations may be given with needles or vaccinostyles. But in the case of a real mass campaign it is preferable to use jet injectors. Doubtless, the Ped-O-Jets are less indispensable if vaccinations are integrated into routine activities, but they simplify the work considerably and experience has shown, particularly as regards smallpox vaccination, that take rates are better than when given by scarification or by multiple pressure.

It is necessary, however, to have a staff well-trained, not only in the use of the Ped-O-Jet, but also in its maintenance and repair. Staff members must also know exactly when the Ped-O-Jet must be used with the sub-cutaneous nozzle and when the intradermal nozzle should be used. Finally, all teams leaving on a vaccination tour must be provided with a sufficient number of spare parts.

Although it is always possible to use a single Ped-O-Jet to vaccinate successively with different vaccines the various age groups which are to receive different vaccinations, it is preferable to have several machines. It is thus possible to vaccinate persons simultaneously (for instance, with smallpox vaccine in one arm and measles vaccine in the other) instead of having to keep them waiting at the risk of seeing many of them disappear. Finally, it must be anticipated that from time to time the jet injectors will break down. Consequently, alternate equipment, such as syringes and needles must be provided. Most failures reported in vaccination campaigns are caused by the non-observance of these rules concerning refrigeration and the correct use of the Ped-O-Jets.

IV. TWO-YEARLY CYCLE OR BIENNIAL PROGRAMME

The two-yearly cycle is the one we recommend, whenever circumstances allow it. The age groups to be vaccinated and the vaccines to be used on each visit are shown in Table 1. The protection afforded to each person over a period of years may also be seen. For clarity, we have assumed that the first year would be dedicated to the initial phase of the measles campaign. Actually, this campaign has already taken place everywhere and only the additional campaigns need still to be undertaken. Smallpox, it will be noted, is systematically given to everyone on each visit. It is true that this means giving more vaccinations than are necessary and will be more expensive. However, it will provide extra protection with no major disadvantage other than the consumption of vaccine. Since, unfortuantely, it is not possible to see 100% of the population on each visit, a systematic revaccination on each visit will make it easier to cover that part of the population which was absent on the preceding visit.

Let us go over some of the points of this schedule:

1. Protection against Measles

Except for the first visit, during which all children aged 6 months to 5 years are vaccinated, only children aged 6 months to 3 years are vaccinated. These are, of

course, the susceptible and vulnerable age group. Additionally, children who were vaccinated on the previous visit, when they were aged 6 months to a year, will be revaccinated. For some this will be unnecessary, but it is a good precaution, since we know that failures occur in this group because of the persistance of maternal antibody. It appears that, particularly in rural areas, one visit every two years is sufficient to keep the "susceptible" population at a low level.

2. Protection against Tuberculosis

On each visit, all children 0 to 6 months old (those who are not yet old enough to be vaccinated for measles) will be given BCG vaccine (half the normal dose) as will, in the first year, all children aged 6 to 20 years. During the second visit, children aged 4 to 9 years will be vaccinated. Thereafter, at each visit, only children aged 4 to 20 years will be vaccinated.

Thus, every child will be vaccinated from the earliest age and revaccinated once or twice until the age of 20; this is considered to provide sufficient protection.

3. Protection against Yellow Fever

It is impossible to vaccinate the entire unvaccinated backlog at one time. Therefore, the 17/D yellow fever vaccine will be given on each visit to all children who have been vaccinated against measles, or better still, where discrimination is possible, to those among the children already vaccinated for measles who are over one year old. Thus, in a few years, all susceptible children will have been vaccinated. Every 10 years, beginning with the second or third visit, the entire population over 10 years old will be vaccinated with the Dakar strain yellow fever vaccine. Once, on the fifth visit, persons aged 10 to 13 years may be given this same vaccine, in order to fill a gap.

It is to be noted that this is a general outline. For financial reasons, it may only be possible in some cases to buy small quantities of Dakar strain yellow fever vaccine. In this case, it would be possible to vaccinate each year part of the population over 10 years old so as to cover the entire population over a period of 10 years and to revaccinate it every 10 years. If, again for financial reasons, it is impossible to buy yellow fever vaccine for the entire population, it will be preferable to obtain in the first instance only 17/D strain vaccine for the protection of children. Finally, this protection could at first be limited to children living in areas recommended as priority areas, particularly large urban centres. However, considering the gradual decrease of the cost of 17/D strain vaccine produced in Dakar, it is not unreasonable to hope that all age groups may soon be protected with this vaccine.

CONCLUSIONS

On the basis of what we now know, it is possible to associate several vaccinations. In OCEAC, these will be integrated in the normal activities of polyvalent teams who will visit all localities at least every two years. It will thus be possible to obtain excellent coverage of the population. This schedule may be further improved when we have evidence that the measles vaccine can be associated with BCG vaccine with no disadvantages. This is at present being studied. If the results, which will be made available in July, are favourable, (and we have reasons to believe that they will), the vaccination schedules described here will be drastically simplified and our last obstacles will have been overcome.

Table 1. Schedule of Vaccinations in a Two Year Campaign
(Frequency of visits - every 2 years)

	Population Under 10				Population Over 10	
Year	0-6 months	6 months to 3 years	4 to 5 years	6 to 9 years	10 to 20 years	Over 20 years
1	S BCG	Smallpox Measles 17/D		S BCG	S BCG	Smallpox
3	S BCG	S M 17/D	Smallpox BCG			Smallpox
5	S BCG	S M 17/D	S BCG	S		Smallpox Dakar
7	S BCG	S M 17/D	S BCG	S		Smallpox
9	S BCG	S M 17/D	S BCG	S		Smallpox Dakar
11	S BCG	S M 17/D	Smallpox BCG		S BCG	Smallpox

Continue thereafter as in 5th, 7th or 9th year in the table, depending on whether or not it is necessary to vaccinate for yellow fever after age 10.

S = Smallpox vaccine
BCG = BCG vaccine
17/D = 17/D strain yellow fever vaccine
M = Measles vaccine
Dakar = Dakar strain yellow fever vaccine

PROGRAMME COSTS AS RELATED TO VACCINATIONS, MORBIDITY AND MORTALITY IN THE GAMBIA

P. J. N'Dow[1]

During the attack phase of the programme, in which 315,000 smallpox and 81,000 measles vaccinations were given in the Gambia, total costs for the campaign were $87,000 (Table 1). For the smallpox programme alone, it was estimated that $39,000 would have been spent. The calculated cost per smallpox vaccination was $0.124. The calculated cost per measles vaccination was $0.593.

During 1967, 4,150 cases of measles were reported. Since the conclusion of the attack phase in April 1968, there have been only 43 cases of measles reported (through 22 March 1969). Thus, a year after the initial programme, reported measles was reduced by at least 90% and with continued vaccination the incidence of the disease should be able to be maintained at this new low level. Based on a potential incidence of 14,000 cases of measles a year, we estimate that for $48,000, more than 13,000 cases of measles were prevented. This is a cost of $3.69 per case prevented. Using a case mortality rate of 5%, the estimated cost per death prevented is $73.85.

A breakdown of the major components of the overall costs for the programme permits the identification of particular expenses, which can then become the target of a cost reduction campaign. In the Gambia, the two most expensive items were the cost of measles vaccine and the cost of U.S. technical advice.

There are several ways to reduce the overall expense of the vaccine:

1. More specific definition of target age group. Much vaccine is wasted in the vaccination of immunes. There will be immunes in every age group, but in progressively larger proportions in progressively older groups. We have estimated that in our initial programme, in which measles vaccine was given to everyone between 6 months and 6 years of age, approximately 60% of all vaccinations were given to persons who might be immune. This percentage can be reduced by either reducing the age limits of the group, or, preferably, by a process of selecting immunes out of the target group for exclusion from vaccination. As the programme undertakes continued maintenance vaccinations, additional care will have to be exercized to avoid revaccinating children who were vaccinated for measles during a previous campaign.

2. Reduction of loss of vaccine. Vaccine loss can be diminished by reducing the number of shots fired while testing a Ped-O-Jet by preventing vaccine spoilage through better conservation procedures, and by using smaller vaccine vials to avoid discarding excesses of reconstituted vaccine.

3. Reduction in the dose of vaccine. Obviously, a reduction in the size of the immunizing dose would reduce the cost per child immunized. We are aware of the interesting work in this area by our colleagues in Dakar, as well as other research workers, and are hopeful that in the not too distant future a reduction in the individual dose of measles vaccine will be a possibility.

4. Reduction in the cost of vaccine. We are, indeed, pleased to learn about the recent 30% decrease in the price of further attenuated measles vaccine being made available from the United States. From discussions with some representatives of drug firms based in the United Kingdom, I am glad to report that the trend is more general, as evidenced by the price of vaccines indicated in their quotations.

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The second largest portion of the total cost of the Gambian attack phase was the amount of money charged to time spent by U.S. technicians. One would expect this to be a continually decreasing cost as the effect of training of our local personnel began to be manifest. Indeed, during the first year of our programme, approximately 130 U.S. advisor days were spent in the Gambia. During the subsequent year, this was reduced to 31 days.

There are additional factors which need to be considered in a cost-conscious approach to the organization of mobile campaigns:

1. A collection point system in which several villages come to a central point versus the village-by-village approach. Relative coverage rates could be compared using the two techniques and a decision on operational strategy made on the basis of savings in terms of time and gasoline and the relative coverage rates observed. So far in the Gambia we have continued to use the village-to-village approach.

2. The use of semi-permanent bases of operation with teams returning to the same base for periods up to one month as opposed to the teams sleeping in the last village vaccinated that day or in the first one to be vaccinated the following day.

   A strategy involving the use of semi-fixed bases of operation is more costly in terms of lost time and gasoline but its use must be evaluated against refrigeration requirements, team morale, supervisory control, etc.

3. A final point, obvious as it is, will be made for the sake of emphasis. It concerns not so much a reduction of costs per se as it does the broader uses of the same operation. I am referring to the possibility of increasing the number of antigens offered as a means of taking a greater advantage of the delivery system used. As a natural outgrowth of our first two years experience with measles/smallpox vaccinations, the Gambia strongly endorses the concept of a multiple antigen vaccination programme. We are hopeful that such a programme can become an operational reality in the very near future.

Table 1. Costs of Attack Phase of Smallpox/Measles Programme in the Gambia

Item	Cost of Combined Smallpox/Measles Programme	Percent of Total	Estimated Cost for Smallpox Alone	Percent of Total for Smallpox Alone
Measles Vaccine (85,000 doses)	$37,400.00	43		
Smallpox Vaccine (350,000 doses)	4,550.00	5	4,550	12
Syringes, Iodine, Cotton	800.00	1	400	1
Ped-O-Jets*	4,400.00	5	2,200	6
Ped-O-Jets parts	200.00	1	100	(0.3)
Refrigerators*	700.00	1	350	1
Trucks*	6,000.00	7	6,000	16
Truck Spare Parts	1,150.00	1	1,150	3
Field Equipment*	1,100.00	1	14,880	39
U.S. Aid Technicians**	19,700.00	21	4,000	10
Direct Gambia Costs (Petrol, etc.)	4,000.00	5	4,700	12
Indirect Gambia Costs (personnel, etc.)	7,000.00	8		
TOTAL	$87,000.00	99	38,330	100

* These items were prorated over 2 years. Thus, their cost during the attack phase represents one half their total cost. The Ped-O-Jets and vehicles could probably be prorated over a 5 year period, thus these data should be considered as maximum amounts.

**Computed at $98.29 per adivosr day. 139 days represents .....$ 13,662
Gasoline per team .....$ 3,686
Apportioned cost of Atlanta and Lagos administrative support.....$ 2,400

$ 19,748

SUMMARY

D. A. Henderson[1]

The papers and discussions dealing with programme operations have clearly pointed up the future direction which this programme may take and the future would appear to be promising indeed. Certainly, the methods employed in programmes in different countries and in various areas within a given country have been, are and will be diverse. In some areas, the small specialized teams have been found most effective, in others the multipurpose teams; some have found the jet injectors to be indispensible while others have favoured the bifurcated needle; most programmes have vaccinated at assembly points while some have found the home-by-home approach to be most useful; traditional vaccination schedules have been questioned and alternative schedules proposed. However, the most important principle, so vividly illustrated in this session, is that there is no single, universally applicable formula for the conduct of a successful immunization programme or, more broadly, for a programme of disease control or eradication.

The ultimate objective of this programme is to eradicate smallpox and to control measle A dual approach is employed; the specific attack, based on the interruption of transmission through application of case and outbreak containment measures and the more general attack which consists of the widespread administration of vaccine to raise the overall immunity of the population. We should like to execute these procedures as efficiently and as economically as possible. While a rigid, universal formula for execution of these aspects of the programme would be administratively "tidy", (and such is regrettably too often the dream of international planners), it is abundantly clear that the differences from country to country in terms of existing health structures, in terms of geographical, political and ethnic differences and in terms of available resources, recommend quite different methods in different areas. It is also quite clear that different methods have been comparably successful.

I would hope, however, that none of you have now decided, once and for all, that you have perfected the ultimately efficient methods and techniques. The methods in use will need to be evaluated constantly through assessment and surveillance and examined frequently in terms of costs of the programme and benefits to the population. Modification and adaptation is to be expected and desired. I would hope that this critical examination would continue and that your observations will be conveyed to others elsewhere in the world.

I believe this eradication programme has served to open up new vistas in immunization techniques and in disease surveillance. In considering the future, let us not forget that preventive medicine is far less costly than curative medicine and that immunization, by and large, is the least costly procedure in preventive medicine. In many of the countries in this region, consideration is being given to the possibility of extending this programme to the control of other diseases through immunization. I believe this is sound. In so doing, I would urge, however, that four points be kept in mind:

1. Immunization schedules and practices recommended for use in Europe and North America should be re-examined in their entirety. None of those of which I am aware are fully relevant to the needs and resources of countries in other parts of the world (and, for that matter, I am not so certain that most are optional for Europe or North America either). Vaccination schedules and use should be carefully reconsidered as they pertain to African needs and resources. I am confident that these schedules can and should be radically reconstructed to balance maximum protection and minimum cost.

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2. Vaccine potency must always be a matter of primary concern. I need only note that when the global smallpox programme began, not more than 10% of vaccine in use in endemic countries met requisite standards. I suspect that if we were to check other vaccines in current use, produced in countries where there is no independent national control authority, the result would be far worse.

3. Surveillance is the most vital part of the programme. As the objective of disease control programmes is to reduce disease incidence, some system is mandatory to insure that incidence is indeed being reduced. This seems like a very obvious axiom. As you know, however, millions upon millions have been "vaccinated" with impotent vaccine, for example, in statistically successful programmes while publichealth officials have complacently congratulated themselves as disease incidence rose, either undetected or ignored. Unless some form of surveillance is instituted to determine whether or not results are being achieved, it is doubtful that a programme should be initiated at all.

4. The results achieved to date are not permanent. Newborns enter the population each year; migrants from poorly vaccinated remote areas and from other countries congregate in town and cities. The threat of smallpox remains for all so long as the disease persists anywhere. For this area, you may expect to be particularly at risk for many years to come, particularly from Ethicpia, a country which is recognized to be heavily endemic and which as yet has no programme whatsoever. Thus, while looking to the new, we must not forget the old. Continuing programmes of vaccination are requisite and, more than anything, constant vigilance.