Chapter Three

CONTROL OPERATIONS

Larviciding[a] operations were very limited (see p, 25) and only residual spraying and the administration of drugs are considered here. The epidemiological effects of the control operations are considered in subsequent chapters.

Residual Spraying

The planning, execution and operational results of residual spraying with propoxur have been described in three Technical Notes (14, 104, 127) andin the report on the control operations (179) and only the salient points are presented here.

Sprayable surfaces

The following surfaces were sprayed: the inner surface of walls and roofs of walled buildings (mostly round huts) excepting the lower 20 cm of the walls; the undersurface of furniture; the eaves of huts, the undersurface of the roofs of sheds; the undersurface of granaries. Prior to the intervention phase, a detailed geographical reconnaissance was carried out, and a survey was made of the sprayable surfaces of compounds in the area to be treated. This revealed a fair uniformity in the sprayable surface per walled hut; this surface is obtained by dividing the sprayable surface of a compound by the number of huts in the compound and includes the surface of the furniture, granaries and sheds belonging to the hut (mean 35.8 m²; SD 6.7 m²). On the other hand, the sprayable surface per compound varied greatly (mean 123.2 m²; SD 89 m²), depending chiefly on the number of huts per compound. The estimates for the spraying operations were therefore based on the number of huts, taking into

a The spraying operations were conducted by Mr R.V. Nambiar, Mr P.E. Lietaert, Mr E. Ramos-Camacho, and Mr V.R. Nair; thc MDA operations were conducted by Dr T. Matsushima, Mr J. Storey, Mr D. Thomas and Mr S. Brogger.

account that the sprayable surface per hut was 34 m^2 in compact villages and 38 m^2 in scattered villages.

The number of villages, the geographical area involved and the human population concerned have been given in Table 2. The number of huts to be sprayed increased from about 29 700 in the first round to about 34 100 in the sixth round. The total surface actually sprayed increased at the same time from about 1 036 000 m^2 to about 1 182 000 m^2.

The spraying operations

Propoxur 50% water-dispersible powder, suspended in 10 parts water, was sprayed with Hudson X-pert compression sprayers (3 gal US; 11.71) equipped with nozzle tip HSS 800 3E (G). A new swivel nozzle body (PA S.152) was introduced in 1973 to facilitate spraying eaves and the under-surface of granaries. The discharge rate was checked weekly and the pressure regulator was reset to give 760 ml per minute at a nozzle pressure of 18 psi.[a] The intended dosage was 2 g technical propoxur per m^2 of sprayable surface.

A total of 75 persons were engaged in the operation. This included 26 spraymen in 9 teams (8 regular teams of 3 and 1 mop-up team of 2). The staff was recruited locally. Spraymen received 2 weeks of training in 1972 and again in 1973. The surface sprayed per day per sprayman was about 1280 m^2 or 1 O- 11 compounds in compact villages, and about 800 m^2 or 6 to 7 compounds in scattered villages.

In 1972, 3 rounds of spraying were applied, starting on 1 May, 5 July and 6 September, respectively. The interval between successive rounds in the same village was 61-66 days. Each round of spraying was completed about a week before the next one was started, and, in part of the area, there was some increase in vector density before the first application of insecticide. In 1973, spraying was begun earlier, and the rounds of spraying were started on 17 April, 16 June and 16 August, and a fourth round (seventh round overall) was applied to the southern half of the area, starting on 15 October. The interval between successive rounds in the same village was 56 days between rounds 4 and 5, and 60-66 days thereafter. The timing of the spraying rounds in 2 particular villages (Rafin Marke and Sugungum), is indicated in Fig. 10 and 11.

Operational results: the coverage achieved and the dose applied

Coverage was defined as the percentage of huts completely sprayed among those existing at the time of spraying. It was very high in most

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a 18lb/in² = 931mmHg = 124 kPa = 138 kN/m².

villages at most rounds. For the whole area, the coverage varied by round from 96.6% to 99%. Among all villages and rounds, it varied from 74% to 100%. In the villages selected for follow-up, coverage was 99% on the average, and varied, among villages and rounds, from 84% to 100%.

Coverage was measured immediately after spraying. The actual coverage must be somewhat lower, because between rounds some new houses are built and some old ones are repaired; this happened mainly between the first and second round of each year. Some sprayable structures may, in addition, have been missed altogether (i.e., counted in neither numerator nor denominator); the number of such structures was probably very small. One small compact village had been missed in 1972.

The average dosage of technical ingredient actually applied varied, between rounds, from 1.98 g/m² to 2.43 g/m² of sprayable surface (2.15-2.43 g/m² in 1972, 1-98-2.20 g/m² in 1973). The amount of insecticidal formulation applied per round varied, among rounds 1 to 6, from 2282 kg to 2744 kg; the grand total used in 6½ rounds was 15 845 kg.

Administration of Drugs

The spontaneous consumption of antimalarials in the study area, before or independently of the project, was negligible: the 2 dispensaries of the district, in Garki itself and in Gwarzo, are outside the study area proper and were dispensing only a negligible amount of antimalarials to the inhabitants of the study area (148); the ambulant drug pedlars observed in the area's markets were not dispensing specific antimalarials.

Mass distribution of sulfalene-pyrimethamine in 1972-1973

The operations

The plan for mass drug administration is outlined in Chapter 2, in terms of persons eligible and of frequency (see in particular pp. 23-25 and Table 2). The MDA operations are described in greater detail in two Technical Notes (105, 106) and in the report on the control operations (179).

A combination of sulfalene and pyrimethamine was used either as uncoated tablets or in a syrup suspension. Each tablet contained 500 mg sulfalene and 25 mg pyrimethamine. Syrup was supplied in bottles containing 10 ml fitted with a glass dropper; 1 ml of syrup contained 200 mg sulfalene and 10 mg pyrimethamine. At each filling, the dropper delivered an average of 26 drops per ml of syrup. Based on the assumption of an immunity increasing with age, and on the results of the preliminary trial, the dosage by age-group for each drug administration round was

scheduled as follows:

< 6 months	12 drops syrup	=	90 mg sulfalene + 4.5 mg pyrimethamine
6-11 months	20 drops syrup	=	150 mg sulfalene + 7.5 mg pyrimethamine
1-4 years	30 drops syrup	=	230 mg sulfalene + 12.0 mg pyrimethamine
5-9 years	½ tablet	=	250 mg sulfalene + 12.5 mg pyrimethamine
≥ 10 years	1 tablet	=	500 mg sulfalene + 25.0 mg pyrimethamine

Whereas the tablets were given with water, the syrup was given in a solution of sugar or in fruit squash.

The people subjected to MDA outside the follow-up villages were the ***de facto*** population. During the first round all the occupants were registered by compound; each person was given a "person number" and at each round those present were given drugs. Persons who were absent for 2 consecutive rounds were defined as "moved", struck off the register and not counted in the population for that round. Newcorners, including births but excluding visitors (see below) were added to the register.

In the follow-up villages, rosters of occupants were prepared from those used in the demographic-parasitological (DP) surveys which had been conducted for 1½ years before MDA commenced. In this population, a person was classified as "moved" only after being absent for 4 consecutive DP surveys, i.e., for about 9 months. Persons absent for less than 4 consecutive demographic-parasitological surveys were counted as residents.

Thus the denominator used in the calculation of the coverage achieved, i.e., the registered resident population eligible for MDA, was defined differently in the 2 populations (the follow-up villages and the others) and therefore the figures for coverage are not immediately comparable.

Infants born into follow-up clusters No. 6 and 8 in area A2 were excluded from MDA as long as they were found negative by microscopic examination. An additional blood film was taken from these infants between consecutive parasitological surveys, i.e., they were examined every 5 weeks. The same rules were applied to infants born into follow-up clusters No. 5 and 7 from September 1972 onwards, i.e., after the 10th fortnightly MDA (a fortnight before the 10th parasitological survey); previously they had been included in the MDA. Infants were excluded, in order to evaluate residual transmission.

The operation was carried out by compound-to-compound visits. Every person was called by name, and the drug was given by a staff member who made sure that it was swallowed before he recorded administration. Drugs were never left for absent people to take later. Those who were absent on the first visit were, as far as possible, given the drugs on a second visit later the same day or on the next day.

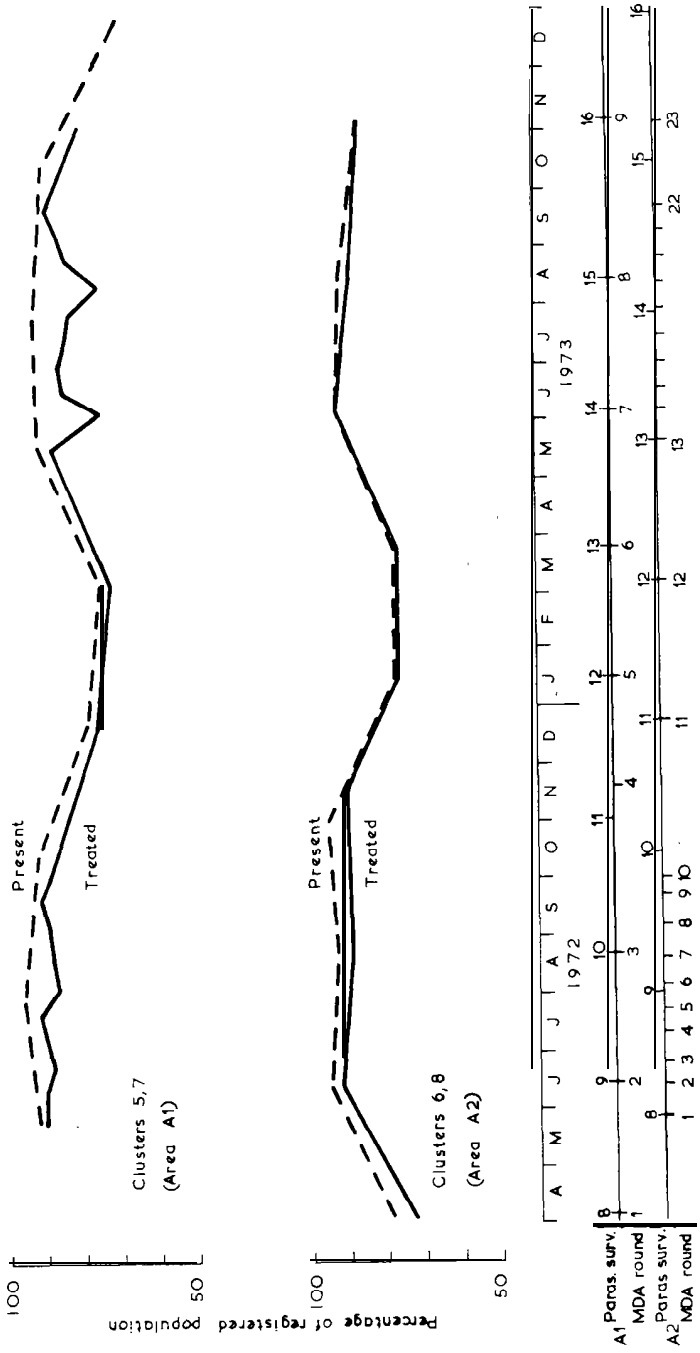


Fig. 5. Percentage of the registered population present at each parasitological survey and percentage treated at each round of mass drug administration (MDA) in 2 groups of villages where MDA was applied throughout the intervention period at 2 different frequencies (2-week and 10-week intervals)

In addition to the occupants registered by compound, visitors encountered in and around compounds at the time of administration were also given drugs, and recorded separately.

A total of 14 persons were engaged in the MDA, including 5 teams of 1 drug distributor and 1 record keeper each, mostly recruited from the district itself and trained for 1 week. Per day, each team covered 150-180 persons (25-30 compounds) in the compact villages, 90-100 persons (15-17 compounds) in the scattered villages.

The actual timing of the MDAs in the follow-up villages, as well as their relationship to the demographic-parasitological surveys, is shown in Fig. 5 in the upper line for the high-frequency MDA and on the lower line for the low-frequency MDA. The parasitological surveys were usually conducted at the end of the interval between consecutive MDAs; this means that most probably only the maxima of prevalence of parasitaemia were observed.

Operational results: the coverage achieved

Coverage was expressed as the proportion of the registered resident population treated at each MDA. In the follow-up villages, infants excluded from MDA were also excluded from the calculation of coverage. The recorded coverage of visitors was always lOO%, which probably means only that, if a visitor was assessed and recorded, the person was also treated; they were excluded from the computation of coverage. The number of recorded visitors varied, by the MDA round, between 2.6% and 6.3% of the resident population, for the whole areaA2 excluding the follow-up clusters No. 6 and 8; individual villages showed, as expected, more variation.

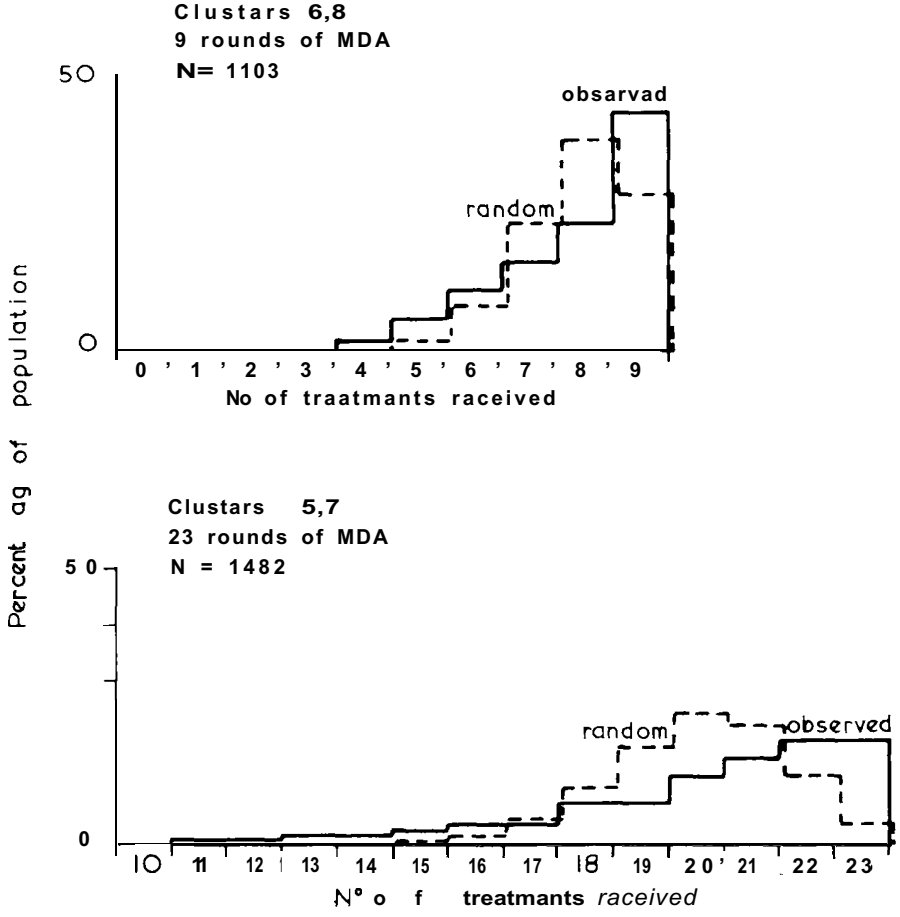
The coverage achieved at each round of MDA in the follow-up clusters is shown in the upper graph of Fig. 5 for the high-frequency MDA, and in the lower graph for the low-frequency MDA. The number of persons present at each demographic-parasitological survey and the number of persons treated at each MDA are expressed as a percentage of the registered population. In both groups of follow-up clusters, the coverage was 85% on the average, greater in the wet season, smaller in the dry season; the seasonal variation in MDA coverage followed closely the seasonal variation in absenteeism from the village (see Chapter 8), there being no long-term trend. In follow-up clusters No. 6 and 8 (AreaA2) the coverage varied, by round, between 73% and 92% (by round *and* village it varied between 69% and 99%); in follow-up clusters No. 5 and 7 (area Al), coverage varied, by round, between 72% and 91 %

In the remainder of area A2, i.e., outside the follow-up clusters, the recorded coverage was 95% on the average and varied little by either round or location. Since the registered resident population was defined in

a different (narrower) way than in the follow-up clusters (see above), the figure for estimated coverage was heightened.

In follow-up clusters No. 6 and 8, where each MDA was given immediately after a demographic-parasitological survey, we can compare the resident population registered by the MDA rounds to that registered by

Fig. 6. Percentage distribution of persons according to the number of treatments received in the entire intervention period, at 2 different frequencies of MDA: comparison between the distribution actually observed and the binomial distribution with the same average[a]



a N = number of eligible persons, i.e., persons registered throughout the intervention period excluding a very small number of negative infants not eligible for MDA.

the demographic-parasitological surveys, and also relate the number of residents treated to the number present. The resident population, as enumerated by the MDA rounds, varied between 91% and 103% of the resident population as enumerated by the demographic-parasitological surveys. The MDA covered, on the average, 95% of the residents registered and present (excluding ineligible infants), and this proportion varied, by round, between 91% and 99%, without detectable pattern.

In each of the 2 groups of follow-up clusters receiving MDA, the persons registered throughout the intervention phase, i.e., eligible for MDA at all rounds, were classified by the number of times they had actually received the drugs, i.e., O-9 times in clusters No. 6 and 8, O-23 times in clusters No. 5 and 7. The resulting frequency distributions (Fig. 6) may be compared with the distribution that would have been obtained if each round of MDA had drawn an independent random sample of participators from the population, while achieving the same overall coverage. It can be seen that the actual distribution is very different from random; there is a clear excess of high and low persona1 MDA scores, i.e., of "good" and "bad" participators.

Post-intervention drug distributions in 1974-1975

The rationale and general plan of the post-intervention drug distributions in 1974-1975 have been outlined in Chapter 2 (see p. 25). Drug administration to persons reporting fever has been described in a Technical Note (151).

Starch-coated chloroquine phosphate tablets were used and the following doses of chloroquine-base were administered: below 1 year of age, 75 mg; at l-3 years, 150 mg; at 4-9 years, 300 mg; at 10 years and above, 450 mg, In the follow-up clusters No. 5 and 7, i.e., the villages previously receiving high-frequency MDA, and in which investigations were continued, there were 4 systematic distributions of chloroquine at intervals of 5 weeks for those born (probably) after 1 January 1962, i.e., those aged less than 10 years by 1 January 1972, a date 3 months before intervention commenced. Rounds 1 and 3 followed immediately upon demographic-parasitological surveys 18 and 19; rounds 2 and 4 were given halfway between surveys 18 and 19 and surveys 19 and 20, respectively. The timing of the surveys is shown in Fig. 43.

In addition, in 1974 and 1975 in all villages previously receiving MDA, chloroquine was given to persons reporting fever. In the follow-up clusters No. 5 and 7, the drug was dispensed by project staff; 62 treatments were given to 59 persons in 1974, while 224 treatments were given to 193 persons in 1975. The percentage of the examined population that was treated varied from 0.7% to 7.3%, depending on the follow-up cluster

and period (lO-week interval in the wet season). In the other villages, the distribution of chloroquine was handled by a selected villager who had been given a short instruction. Consumption was somewhat higher: in the wet season of 1974, the proportion of the population reporting fever and requesting treatment was 9.5% per fortnight on the average.

Discussion

Withrespect to the control operations, the following points merit some discussion: the definition and evaluation of coverage, the non-randomness of coverage, the consciousness and participation of the community in the use of antimalarials.

The definition of coverage is to some extent arbitrary, and its evaluation confronts some difficulties. This applies in particular to the coverage of the human population by a measure such as MDA, especially when no satisfactory census is available and when the population is relatively mobile. It is relatively easy to count the number of persons treated (the numerator). It is more difficult to define and to measure the number of persons that should be treated (the denominator): the resident population was probably nearly completely registered, but visitors were counted to an unknown degree of completeness, and only at points in time, and the duration of their visits is not known; in the registered population, an arbitrary rule was adopted for reclassifying long-term absentees as moved and subtracting them from the registered population, which rule for practical reasons varied between areas. When this is taken into account, it is probable that there were no real differences of coverage between the two pairs of follow-up clusters (No. 6 and 8, No. 5 and 7), or between the follow-up clusters and the surrounding area, i.e., the remainder of area A2.

The distribution of persons eligible for MDA by the number of treatments actually received was very different from random. This may be expected every time arepetitive measure is applied to a population. Ignoring this leads to an overestimation of the expected proportion of persons covered by the measure, and of the expected effectiveness of the latter; e.g., from an 80% coverage, it may be expected that, after 2 and 3 rounds, respectively 96% and 99.2% of persons will have been treated at least once, whereas in reality the proportion may be much lower. When computer simulations were used to calculate the expected effect of MDA in Kankiya, northern Nigeria (100), it was assumed (implicitly) that coverage was random at each round of MDA. *A posteriori,* it was shown that, as in Garki, the distribution was non-random, and this was probably one

of several reasons why the level of control achieved fell short of expectations (126).

Knowledge and utilization of antimalarials in the study area were practically negligible before the research project commenced. As a by-product of the project, the villagers now have an increased awareness of malaria and of the possibility of its treatment and prevention. They have acquired a modest capacity for self-help with drugs. The health services of the Kano State are expected to continue to provide the drugs.

Summary

Residual spraying with propoxur was applied, mainly to the inside of buildings, in 164 villages (including follow-up clusters No. 3-8), distributed over 900 km^2 with a total number of huts of about 30 000 and a total population of about 50 000 persons. Three rounds were applied before and during the wet season of 1972; there was some increase in vector density before the first round was completed. In 1973, spraying was started earlier, beginning in the south, and a fourth round was applied to the southern half of the area. The interval between rounds of the same year was about 60 days. In $6\frac{1}{2}$ rounds, about 16 000 kg of propoxur (50% water-dispersible powder) were applied, and the average dose was 2.15 g/m^2 (the intended dose was 2 g/m^2). Coverage, expressed as proportion of huts sprayed, was 99% on the average in the follow-up villages, and varied little between rounds or villages; since coverage was estimated immediately after each spraying round, the "true coverage" must be somewhat lower, due to building and repair activities between rounds.

Mass drug administration (MDA), using a combination of sulfalene and pyrimethamine, was applied in 60 of the sprayed villages, with a total population of about 16 000 persons, in 1972-1973, i.e., during the 2 wet seasons in which propoxur was used, plus the intervening dry season. In 6 villages (follow-up clusters No. 5 and 7), MDA was applied every 2 weeks in the wet season, every 10 weeks in the dry season, up to a total of 23 rounds; in the remaining 54 villages (including follow-up clusters No. 6 and 8) MDA was applied every 10 weeks for 9 rounds. Infants were excluded from MDA as long as they were negative; visitors were included. The proportion of the registered population covered by MDA was 85% on the average, more in the wet season, less in the dry season, owing to seasonally variable absenteeism from the villages and the study area. The distribution of eligible persons by the number of treatments actually received was not random, and showed an excess of persons receiving both more and less than the average number of treatments, i.e., an excess of

both "good" and "bad" participators; ignorance of this fact has led in the past to exaggerated expectations regarding the effect of MDA transmission.

The interventions in 1972-1973 had been planned as time-limited operations for research purposes. In 1974-1975, in the villages previously included in the MDA operations, chloroquine was used in a selective manner to minimize the effects of the expected return of the prevalence of ***P. falciparum*** towards its original endemic level. The operation included the administration of chloroquine to self-reported fever cases, by a responsible villager; this was continued after completion of the research project early in 1976.