The Central African Journal of Medicine

Editor:
MICHAEL GELFAND, C.B.E., M.D., F.R.C.P.

Assistant Editor:
JOSEPH RITCHKEN, M.D.

Volume Nineteen

JANUARY - DECEMBER

1973

SALISBURY : RHODESIA

Report on a Large-Scale Attempt at Control of Bilharziasis by Combined Mass Treatment and Intensive Snail Control

BY

FIONA MACDONALD,
V. de V. CLARKE,
P. GADDIE
AND
GERALDINE ATKINSON

Blair Research Laboratory, Salisbury, Rhodesia.

Introduction.

The biology of the schistosome parasites allows many theoretical methods of interruption of its life cycle, and therefore control of the spread of the infection or consequent disease. It must be accepted that the practical value of any one method of control can only be assessed if that method is used by itself in an endemic area. For this reason there have been reports from many endemic areas on attempts at the evaluation of the different possible control measures.

The attempts at the chemical control of the snail hosts of the parasites have demonstrated that under suitable circumstances the use of a molluscicide in specified areas can result in effective control of transmission (Clarke and Shiff (1968); Shiff *et al* in Press). On the other hand the control of the transmission of the parasite by mass chemotherapy has had a lasting effect in only a few isolated cases.

Failure of this method of control is to be expected, even with an ideal chemotherapeutic drug, unless measures are taken to prevent re-infection of treated people.

Other methods of control have also been attempted. These include water management, highly effective in the control of the amphibious snail hosts of *Schistosoma japonicum,* but to date of only limited value against *S. mansoni* or *S. haematobium* infections, and the raising of standards of rural hygiene and sanitation. This would appear to be the most important method of control of transmission of bilharziasis, but it is costly and time-consuming, and it requires concurrent long-term intensive health education to be effective. Substantial improvements in hygiene, sanitation and water management, and, possibly modification in some human behaviour patterns, should lead to the eventual control or even elimination of bilharziasis, but it appears that chemical control of snails combined with mass chemotherapy of the infected population affords the best immediate control of the infections.

Over the last two decades the molluscicides available for use in the field have shown great improvement, as have the drugs available for mass chemotherapy. The two molluscicides best suited for wide-scale use are Niclosamide (Bayluscide: Bayer) and N-trityl-morpholine (Frescon: Shell Chemicals). Each of these molluscicides has advantages and disadvantages, and for any waterbody the molluscicide to be used must be selected with care.

For the mass treatment of infected persons the drug most practical for wide-scale use is hycanthone (Etrenol (R): Winthrop), since this drug is administered by a single intramuscular injection which is generally safe provided there is a strict adherence to the recommendations and contra-indications for use.

With the extensive knowledge of the use of molluscicides that has been developed in recent years, particularly in Rhodesia, and with the availability of Etrenol for wide-scale use, it was decided to attempt a large-scale field trial using Etrenol to treat all schistosome infections in people living in a prescribed area and to couple this mass chemotherapy with intensive snail control by the application of molluscicide followed by the system of surveillance described by Clarke and Shiff (*op. cit.*)

The area selected for this control was the Burma Valley — a tobacco, cotton and fruit farming area lying along the border of Rhodesia with Mocambique. The Valley is encircled on three sides by mountain ranges which restrict movement of people, and also enclose a river catchment system flowing west-east, the whole of which could be subjected to snail control for the purposes of this experiment.

Labourers and their families employed on the 20 farms in the area total approximately 2 000 people. The majority of these people are resident in the area for most of the year although additional labour is imported during peak farming periods of November to May.

Methods.

A. *Snail Control*

The snail control programme was started in the Burma Valley in September, 1969, when a blanket application of Niclosamide at a concentration of 0,5 ppm was made to all rivers, streams, reservoirs and other waterbodies of the area. A total of 7,7 kg Niclosamide was applied to water reservoirs, but in general it was found that only the shallows on the periphery of such reservoirs needed treatment. 20,5 kg Niclosamide were required for the initial treatment of the natural water-courses, after which a surveillance system of control was employed: under this system all waterbodies were inspected at 3-week intervals, and if any persisting foci of snails were found, the chemical was applied immediately to eliminate those foci. No quantitative sampling of snail populations was done, but continual searching and scooping for snails demonstrated that successful control of these snails had been achieved, as very few snails could be found during the period under consideration. This system of surveillance has been maintained from the end of 1969 to the present (1973).

Urine and Stool Surveys.

B. *Collection of Specimens*:

Bennie (1949), Jordan (1963) and other workers have reported that the output of *S. haematobium* eggs in urines from infected individuals reaches its maximum at or around mid-day. For practical reasons it was not possible for urine samples to be collected solely during this period of peak output and it was therefore necessary to limit the time of collecting of specimens to the period between 0900 and 1400 hours. Stool specimens for examination for *S. mansoni* infections were collected at the same time. In all cases the name, sex, age, length of residence in the area, and the history of previous treatment for bilharziasis were recorded for each person examined. Great difficulty was experienced in assessing the ages — particularly of the children, because it is rare for rural Africans to be sure of their age. However, an estimation of age was made by an experienced interviewer. The urine specimen was collected first in a 120 ml wide-mouthed, screw-capped bottle. When the urine specimen was returned to the collecting team a similar sized bottle containing approximately 30 ml of 2% saline solution was issued and each person was instructed to use a small wooden spatula to place a faecal sample, approximately the size of a walnut, into this fluid. When the stool specimen was returned to the collecting team the bottle was shaken vigorously to ensure full emulsification of the sample.

On its arrival at the laboratory the bottle containing the urine specimen was allowed to stand for 30 minutes for the sediment to form. The supernatant was suctioned off, taking care not to disturb the sediment, until approximately 12-14 ml of urine remained. The bottle was then shaken vigorously and the contents transferred to a 15 ml conical centrifuge tube and centrifuged for one minute at 1 000 rpm. The supernatant urine in the tube was suctioned off carefully to leave approximately 0,5 ml urine containing sediment in the tube. The

specimen was then ready for microscopic examination and 0,05 ml was removed with a pipette and the eggs in this quantity were counted.

The emulsified stool specimen was prepared and examined as described by Weber (1973).

The diagnostic team made three visits to the Burma Valley during the period September, 1969, to March, 1970, to obtain urine and stool specimens from all farm labourers and their families. From these surveys all positive cases found were offered treatment with Etrenol, as described below, and from the aggregate results of these surveys the initial prevalences of *S. mansoni* and *S. haematobium* in the Burma Valley were obtained. Subsequent prevalence surveys were conducted as follows:

Second prevalance — February, 1971.
Third prevalence —October-December, 1971.
Fourth prevalance — February, 1972.

On all the prevalence surveys an attempt was made to test everyone present in the Valley at the time of the visit, and any new residents found to be infected were offered treatment during subsequent visits.

Surveys to assess the efficacy of the drug used were made on treated persons at the following intervals after the first drug treatment:

(i) 1-3 months.
(ii) 5-7 months.
(iii) 9-12 months.

and three months after each subsequent drug treatment.

Treatment

Prior to a visit to the Burma Valley by the team equipped to administer the hycanthone injections, lists of persons showing infection either by *S. haematobium* or *S. mansoni* or both, were circulated to all employers of the area, together with a notification of the approximate time of arrival of the team. This procedure greatly facilitated the administration of drugs, and the co-operation of employers and employees was invaluable in this respect.

The drug hycanthone (Etrenol (R): Winthrop) was supplied in soluble powder form in 200 mg vials. 2,0 ml sterile water was added to each vial immediately prior to each injection. Each patient was weighed and treatment number and dose for that patient recorded. The patients were subjected to a physical examination, with particular emphasis on liver palpability or tenderness, and an enquiry into the general health of the patient was made. The injections were given into the gluteal region of the buttock. Children were treated only with consent of their parents who were generally anxious for it to be given. All refusals of initial treatment were on religious grounds.

RESULTS.

1. *Treatment of S. haematobium infections*:

The assesment of the efficacy of Etrenol on *S. haematobium* infections on a six-month follow-up examination is shown in Table I and Fig. 1. The efficacy of the drug on *S. haematobium* infections, expressed as the percentage of people no longer passing eggs, is shown to improve with age: in persons over 10 years old 90 per cent. stopped passing eggs, while in the 13-15 age group the figure was 96 per cent. The overall efficacy for *S. haematobium* at six months follow-up examination is 88,5 per cent.

In the uncured category there was an overall reduction in average egg output of 77 per cent.; however, in a number of instances there was an increase in the actual egg output which may be explained by a possible re-infection of the individuals or which may have been due to infections still maturing at the time of treatment; since it is known that treatment with this drug does not affect prepatent infections, these would show up as an increased egg output.

Fig. 1 is derived from the data given in Table I and shows the pattern of average egg output for *S. haematobium* infection according to age, for the pre-treatment and six month post treatment surveys; it also shows the percentage of persons in each group showing apparent cure.

2. *Treatment of S. mansoni infections*:

The efficacy of Etrenol on *S. mansoni* infections is shown in Table 2. There is no age dependance of cure of *S. mansoni* infections apparent in these results, but there is a possibility of an obscuring of any pattern due to the small number of patients examined in the lower age groups. The overall efficacy for *S. mansoni* at six months follow-up examination was 49 per cent.

Since estimations of egg output rather than egg counts were made on the stool specimens (as explained in method above) there is no figure available for specific egg reduction, but of the uncured category 16 per cent. showed a marked reduction in egg output. These, if taken together with the total cures, give the percentage of patients who benefited markedly from the treatment, and this came to 66 per cent. As with the *S. haematobium* assessment, there were a number of instances of an increase in estimated egg output, probably for the same reasons as given above.

Table I.

ASSESSMENT OF EFFICACY OF ETRENOL ON S. HAEMATOBIUM INFECTIONS.
(follow-up examinations 6 months after treatment)

Age Groups	0-3	4-6	7-9	10-12	13-15	16-20	21+	Total
Pre-treatment								
No. passing viable eggs	7	16	33	39	27	33	115	270
Average eggs/infected person	328	521	757	1 120	738	463	333	566
Post treatment								
No. still passing viable eggs	2	7	9	4	1	2	6	31
Average eggs/infected person	420	110	186	63	10	150	23	129
% egg reduction	28	79	75	94	98	68	93	77
% cured of infection	—	56	73	90	96	94	95	88,5

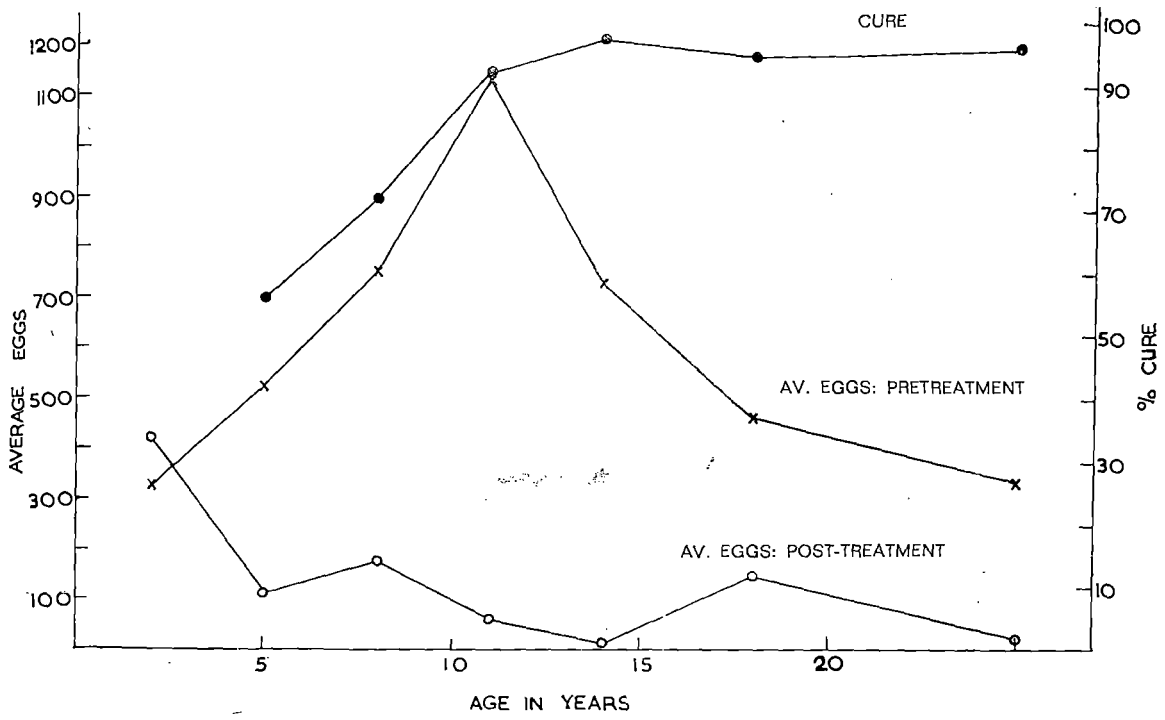

Fig. 1.— Patterns of cure and average egg output of *S. haematobium* before and after treatment.

3. *Re-treatment of initially uncured infections*:

Those persons that were not cured after the first injection were offered subsequent re-treatment, and some were given as many as four injections each. However, the success in collecting the follow-up specimens for these successive treatments was relatively small, and thus the discussion of repeated treatment will be restricted to those receiving two treatments only.

The assessment of efficacy of a second course of treatment with Etrenol on *S. haematobium* and *S. mansoni* infections is given in Table III. The percentage cure for *S. haematobium* (80%) and for *S. mansoni* (57%), do not differ significantly from the percentage cure after the first treatments. Similarly, the proportions of patients benefiting from the second course of treatment are not significantly different from those of the first. This was true for both species of parasite. The results of a second course of treatment should be viewed with a consideration of the possible reasons for failure of the first treatment; these were:—

Table II.

ASSESSMENT OF EFFICACY OF ETRENOL ON S. MANSONI INFECTIONS.
(follow-up examinations 6 months after treatment)

Age Groups	0-3	4-6	7-9	10-12	13-15	16-20	21+	Total
Pre-treatment								
No. passing viable eggs	14	19	37	37	14	35	210	366
Post-treatment								
No. still passing viable eggs	3	6	15	8	8	14	72	126
No. showing marked egg reduction	2	4	7	11	3	8	24	59
No. cured	9	9	15	18	3	13	114	181
% cure	64	47	41	49	21	37	54	49
% benefiting from treatment	79	68	59	78	43	60	66	66

(i) the worms may be resistant to Etrenol;

(ii) in view of occasional increase in egg output observed after treatment of infections, and the reasons given for this, it is possible that a new infection or an infection that was maturing at the time of the first treatment, is being treated by the second injection;

(iii) the rate of absorption of drug into the blood stream and its rate of break-down by the liver are dependant on metabolic activity; where this is high, the length of time that the drug is available to the worms is shorter and therefore the efficacy is diminished, as in very small children;

(iv) it has been suggested that the parasite load may also influence the amount of drug available to each worm;

(v) the toxicity of the drug may vary for different species of parasite or in different hosts (possibly because of differing metabolic activity).

If worm resistance, metabolic activity of the host or maturing infections are major contributions to the failure of the drug at the first treatment, then the cure rate for the second course of treatment would be significantly lower than that of the first course. As this is not the case, these factors cannot be considered as being a major influence on drug efficacy. Therefore the toxicity of the drug for the communities of the worms in these specific hosts must be the major factor determining Etrenol efficacy.

However, metabolic activity of the host does exert an influence on the apparent cure of infections in man. Clarke and Blair (*op. cit.*) discuss this point in detail in the assessment of cure for Niridazole. A similar pattern for apparent cure for Etrenol is shown in Fig. 1. The efficacy of Etrenol is seen to be low in the younger children in whom metabolism of the drug would be rapid because of efficient liver function. In older people, in whom liver function tends to be relatively lower, the efficacy of the drug is increased.

In view of the greatly reduced cure rate of Etrenol and other schistomocidal drugs for *S. mansoni* as compared to *S. haematobium,* and assuming that each species in the host receives the same amount of unmetabolised drug, it is apparent that the toxicity of Etrenol for *S. mansoni* is lower than for *S. haematobium.* This confirms "in vitro" results.

It is of interest to note here that *S. mattheei* eggs were observed in a few stool specimens during the preliminary survey prior to Etrenol administration, but no *S. mattheei* were observed in any specimens after the first series of injections. It would therefore appear that the cure rate of *S. mattheei* with Etrenol is high, although exact figures are not available.

Reports of the after effects of Etrenol treatment of 3 mg/kg both by the patients themselves and their employers were insignificant, the only complaints being soreness at site of injection, lack of appetite, and, in very few cases, nausea and vomiting confined to the evening after the injection. Several women were found subsequently to have been pregnant at the time of injection, and again no adverse effects were reported; and the children, when born, were apparently normal and healthy, on a cursory examination. An increase of the dose rate from 3,0 mg/kg to 3,5 mg/kg gave a marked increase in the side effects of nausea and vomiting without a significant parallel increase in curative effect.

It appears to us that, notwithstanding the several fatalities reported to have followed the use of Etrenol, the drug is safe to use for mass

Table III.

ASSESSMENT OF EFFICACY OF SECOND COURSE OF TREATMENT WITH ETRENOL ON PATIENTS WHOSE FIRST TREATMENT FAILED.

	S. haematobium	*S. mansoni*
Number receiving second treatment	20	90
Number eggs/infected person before second treatment	160	—
Number still passing eggs six months after second treatment	43	—
Number eggs/infected person after second treatment	4	39
% reduction eggs after second treatment	73	—
Number showing marked decrease in egg production	3	4
Number cured of infection	16	51
% cured of infection — second treatment	80	57
% benefiting from second treatment	95	61

chemotherapy in the field, provided there is a strict adherence to the simple precautions recommended by Gane (1971). These may be summarised as follows:—

(i) No person showing or reporting any intercurrent chronic or acute illness should be treated.

(ii) No person with significant enlargement or tenderness of the liver should be treated.

(iii) No person should be given any supplementary medication for three to four days after treatment. (This applies particularly to any group of compounds having liver depressant action; e.g., chlorpromazine).

4. *Influence of control measures on prevalence of infections*:

The treatment of infected persons was undertaken on a voluntary basis. However, there were few refusals, and the results of the three years of combined snail control and mass chemotherapy allowed examinations of the effects of these measures on prevalence of infections.

The prevalence in relation to age for the first three years are given in Tables IV, V and VI.

These prevalence surveys undertaken each year, differed from the post treatment follow-up surveys in that an effort was made to survey every individual present in the area at the time of visiting. Many temporary and new residents to the area were included, together with participants of the drug trial.

The age prevalence of *S. haematobium* infections prior to and at yearly intervals after the snail control and chemotherapy programmes were started, is given in Table IV. A special prevalence survey was also carried out one and a half years after the start of control, but in this, results from treated persons only are included, and they therefore exclude new infections which may have been "imported".

The overall initial prevalence of *S. haematobium* was 39 per cent. and the pattern of prevalence with increasing age is characteristic for *S. haematobium* infections, with a peak prevalence reached in the 10-15 age group. After the first year of control the prevalence is reduced to 18 per cent. with the major drop occurring in the 10-15 age group. This can be seen more clearly from Fig. 4. After two years of control the overall prevalence is 22 per cent. which is slightly higher than after one year. Again the major reduction in prevalence occurs in the 10-15 age group. However, the prevalence of persons continually resident in the area after one and a half years of control and treatment is 10,6 per cent., thus showing that there is a slight bias of results due to infections in new residents to the area in the one year post control prevalence survey, and a larger bias to the results of the second year.

The number of infections expected in a standard population of 1 000 is obtained in each age group as the product of the percentage of people infected and the number of people in that age group in a standard population of 1 000, the latter figure being obtained from the 1960 population census for Southern Rhodesia. Thus in 1 000 people of a standard population it is expected that a total 397 people would be infected. After one year of control and treatment this figure drops to 195 which is an overall comparative reduction of 52 per cent.

After two years of control the number of infections per 1 000 is 223, which is lower than that prior to control, but higher than after one year of control.

The number of infections expected per 1 000 people continually resident in the area is 106 after one and a half years of control, which is a decrease of 75 per cent.

Table IV.

AGE-PREVALENCE PATTERNS OF S. HAEMATOBIUM INFECTIONS IMMEDIATELY BEFORE AND AT YEARLY INTERVALS AFTER MASS CHEMOTHERAPY.

Age Groups	0-3	4-6	7-9	10-12	13-15	16-20	21+	Total
Before control								
Number examined	71	66	140	137	107	159	862	1 542
Number infected	16	30	68	91	79	82	234	600
% infected	23	45	49	66	74	52	27	39
Number of infections expected in standard population of 1 000	32	45	43	55	55	57	110	397
After one year of control								
Number examined	39	85	91	76	30	68	715	1 104
Number infected	2	23	29	21	8	24	90	197
% infected	5	27	32	28	27	35	13	18
Number of infections expected per 1 000 population	7	27	28	23	20	39	51	195
After two years of control								
Number examined	22	48	82	94	121	115	733	1 215
Number infected	2	8	35	38	52	45	87	267
% infected	9	17	43	40	43	39	12	22
Number of infections expected per 1 000 population	13	16	38	33	32	43	48	223
After one and a half years of control								
Persons continually resident in area—								
Number examined	16	35	93	74	43	26	494	781
Number infected	0	4	20	20	11	4	24	83
% infected	0	11	22	27	26	15	5	10,6
Number of infections expected per 1 000 population	0	11	19	22	19	17	20	106

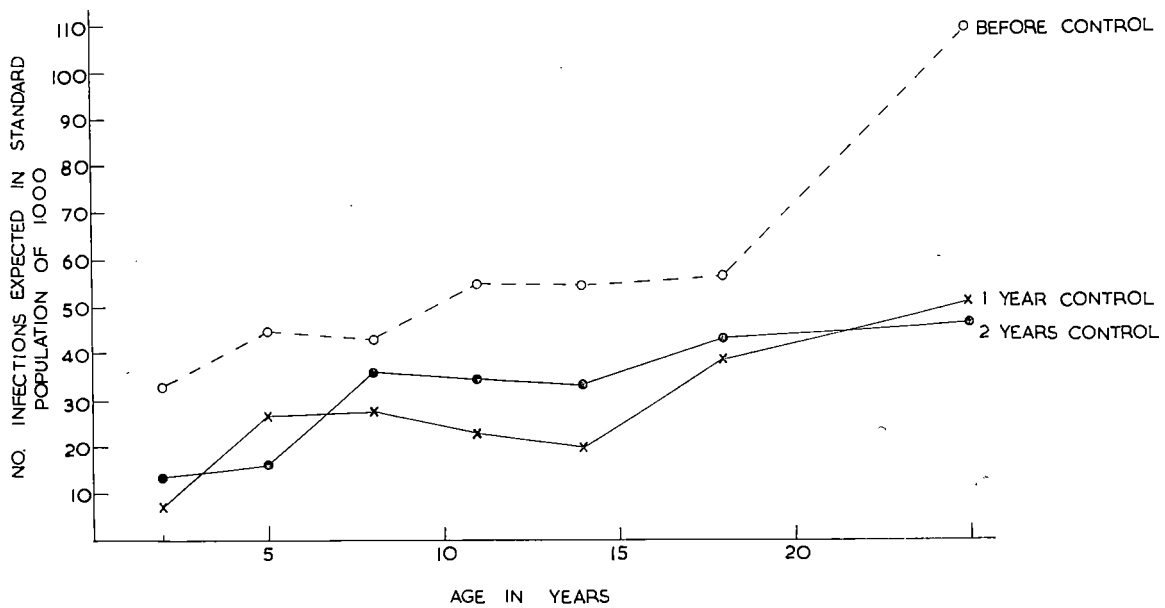

Fig. 2.—Reduction of prevalence after one and two years of control. Prevalence is expressed as the number of infections in a standard population (see text).

Table V.

AGE SPECIFIC PATTERNS OF EGG RELEASE IN S. HAEMATOBIUM INFECTIONS BEFORE AND AT YEARLY INTERVALS AFTER CHEMOTHERAPY.

Age Groups	0-3	4-6	7-9	10-12	13-15	16-20	21+	Total
Before control								
Number tested	71	66	140	137	107	159	862	1 542
Number infected	16	30	68	91	79	82	234	600
Number of eggs	6 700	19 260	89 220	118 160	47 310	33 860	73 130	387 640
Average eggs/infected person	419	642	1 312	1 298	599	413	313	646
Infection pot. x 1 000	13,4	28,9	56,4	71,4	32,9	23,5	34,4	256,5
After one year of control								
Number tested	39	85	91	76	30	68	715	1 104
Number infected	2	23	29	21	8	24	90	197
Number of eggs	1 300	10 650	15 880	13 280	5 530	15 360	18 010	90 010
Average eggs/infected person	650	461	548	632	691	640	311	457
Infection pot. x 1 000	4,6	12,4	15,3	14,5	13,8	25,0	15,9	101,5
After two years of control								
Number tested	22	48	82	94	121	115	733	1 215
Number infected	2	8	35	38	52	45	87	267
Number of eggs	1 110	620	10 800	36 440	29 560	17 070	10 590	106 190
Average eggs/infected person	555	78	309	959	569	379	122	398
Infection pot. x 1 000	7,2	1,2	11,7	31,6	18,2	16,3	5,9	92,2

% decrease in egg output after 1 year = 60%
after 2 years = 64%

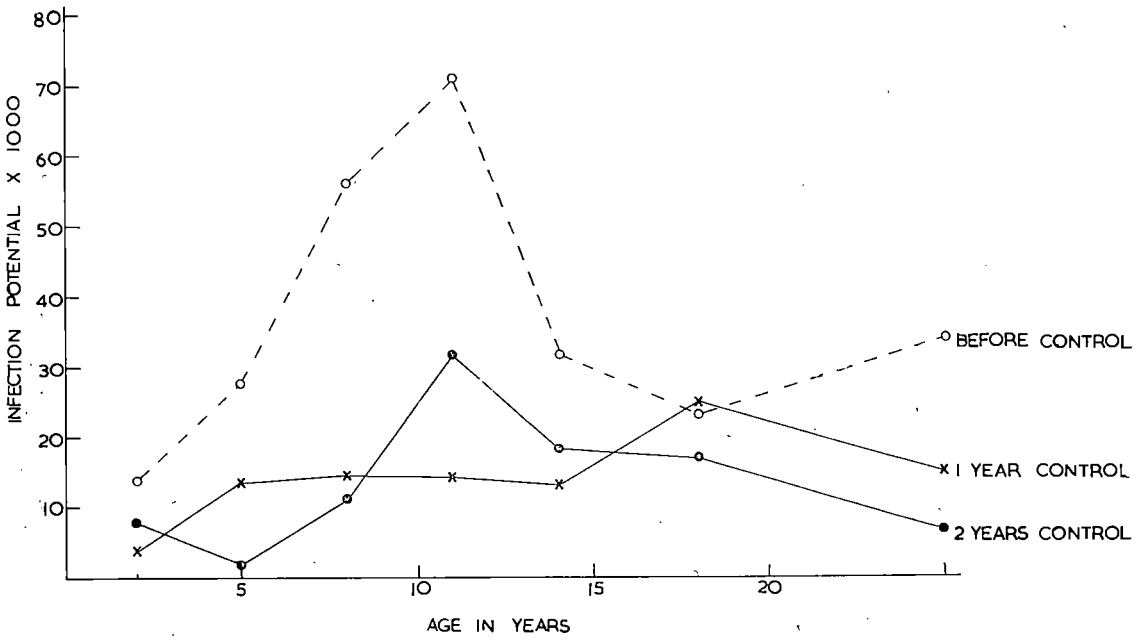

Fig. 3.—Age specific infection potentials of *S. haematobium* after one and two years of control.

Table VI.

AGE PREVALENCE PATTERNS OF S. MANSONI INFECTIONS BEFORE AND AT YEARLY INTERVALS AFTER MASS CHEMOTHERAPY.

Age Groups	0-3	4-6	7-9	10-12	13-15	16-20	21+	Total
Before control								
Number examined	75	70	144	137	105	157	855	1 543
Number infected	29	36	70	80	50	77	409	751
% infected	39	51	49	58	48	49	48	49
Number infections expected in standard population of 1 000	54	50	43	48	36	54	194	479
After one year of control								
Number examined	37	89	94	76	27	65	699	1 087
Number infected	11	36	42	44	11	29	251	424
% infected	30	40	45	58	41	45	36	39
Number infections expected in standard population of 1 000	42	40	40	48	31	49	146	396
After two years of control								
Number examined	23	37	84	95	115	116	724	1 194
Number infected	9	11	43	55	51	54	380	603
% infected	39	20	51	58	44	47	52	51
Number infections expected in standard population of 1 000	6	29	46	48	33	51	213	426

% reduction in prevalence:
after 1 year = 17,3
after 2 years = 11,1

After one and a half years of control — only permanent residents examined.

Age Groups	0-3	4-6	7-9	10-12	13-15	16-20	21+	Total
Number examined	36	37	76	81	29	71	428	758
Number infected	5	10	22	19	11	22	96	185
% infected	14	27	29	23	38	31	22	24
Number infections expected in standard population of 1 000	19	26	26	19	28	34	91	243

After one and a half years in permanent residents % reduction in prevalence = 49,3.

Fig. 2 illustrates the changing patterns of prevalence after one and two years of control.

Egg production patterns in relation to age and age prevalence relationships are normally considered separately: however, the full effects of control in a community can best be appreciated by examining both egg production and age prevalence together. Jordan (1963) referred to an "infection potential" for any age group; he derived this from the product of the average egg production and the prevalence percent in the age group. Jordan used this measure to demonstrate that children were largely responsbile for maintaining the infection of snails and that control measures should be directed towards preventing infection in these children. However, this infection potential demonstrates the dramatic decrease in egg production in older people after a period of control.

The age specific patterns of egg release in *S. haematobium* infections before and after treatment are given in Table V and Fig. 3.

An improvement on Jordan's infection potential is to use as a parameter the product of average egg production and the number of people expected to be infected in a standard population of 1 000. Using this latter parameter it can be seen from Table V that the number of eggs released into the water decreased by 60 per cent. in the first year after control and by 64 per cent. in the second year after control, and the decrease in actual average eggs per infected person was 29 per cent. after the first year of control and 38 per cent. after the second year of control.

The age prevalence patterns of *S. mansoni* infections before and at yearly intervals after mass chemotherapy are shown in Table VI and Fig. 4.

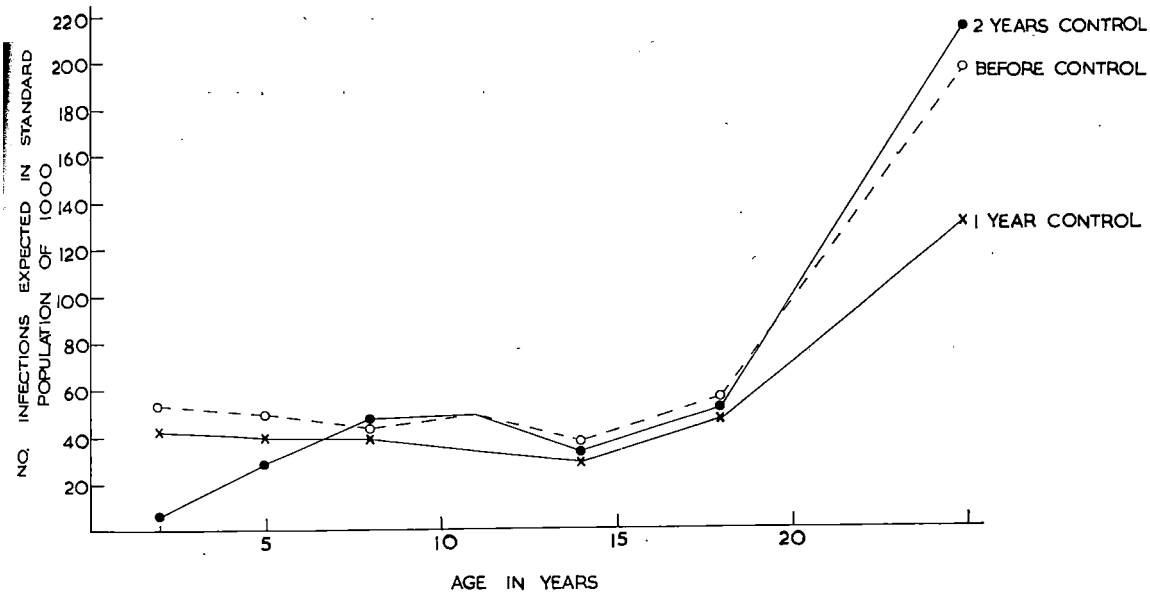

Fig. 4.—Reduction in prevalence after one and two years of control. Prevalence expressed as the number of infections in a standard population (see text).

After one year of control in a standard population the reduction in prevalence is 17,3 per cent. but only 11,1 per cent. after two years of control.

However, in the special survey of persons permanently resident in the area for one and a half years, the prevalence of *S. mansoni* decreased by 49,3 per cent.

No quantitative examinations for *S. mansoni* infections were made, although the density of eggs in the faeces was roughly graded. In those persons still passing eggs after treatment, there was usually an indication of marked egg reduction.

Etrenol has been shown to be less effective in the treatment of *S. mansoni* infections than it is for *S. haematobium,* and this fact alone may account for the disappointing results indicated in Table VI. The use of Etrenol in the treatment of *S. haematobium* infections on a mass treatment basis is so effective that this form of control may well work by itself in the absence of any other measure to limit transmission. However, in this experiment the attempt to control *S. mansoni* transmission by combining mass chemotherapy with snail control in a limited area was considered to be only partially successful. It is felt that the concurrent use of mass chemotherapy using any currently available drugs is possibly uneconomic if it is aimed only at *S. mansoni* infections unless the people are adequately protected against any chance of re-infection either within or out of the controlled area. Emphasis must be placed on snail control in combination with imaginative, practical and intensive prevention of contact with natural water and the prevention of contamination of the natural water.

Summary.

1. An attempt was made to combine snail control with mass chemotherapy of bilharziasis on an extended scale in an isolated but large valley.
2. Successful control of vector snails was achieved in the Burma Valley area using Niclosamide on a three-week surveillance system after a preliminary blanket treatment of all waterbodies.
3. The efficiency of Etrenol in the treatment of *S. haematobium* infections was high (88,5 per cent. cure). The efficacy of the drug improves with the age of the patient.
4. The efficiency of Etrenol in the treatment of *S. mansoni* infections was moderate (49 per cent. radical cure). There is no apparent age dependance of cure rate.
5. In repeated treatments with Etrenol there is no significant difference in the cure rate for both species of schistosome parasite from that of the first course of treatment.

6. Etrenol is safe for mass chemotherapy in the field provided there is strict adherence to the precautions recommended by Gane (1971).

7. The prevalence of *S. haematobium* infections was reduced from 39 per cent. to 22 per cent. after two years of snail control and mass chemotherapy. These results were biased by the inclusion of new residents (i.e., imported infections).

8. The infection potential for *S. haematobium* was reduced to 60 per cent. in the first year of control and by 64 per cent. in the second year of control.

9. The reduction in prevalence for *S. mansoni* on a standard population was 17,3 per cent. after one year and 11,1 per cent. after two years.

10. Control of *S. haematobium* infections by snail control and mass chemotherapy (with Etrenol) proved successful, whereas only partial control of *S. mansoni* infections was obtained.

11. There is evidence of significant egg reduction in people not cured by the treatment.

References.

Bennie, Iris (1949) *S. Afr. med. J.* **23,** 97.

Clarke, V. de V. & Blair, D. M. (1966) *Cent. Afr. J. Med.* **12,** 25.

Clarke, V. de V. & Shiff, C. J. (1968) *Cent. Afr. J. Med.* **14,** 161.

Gane, N. F. C. (1971) *Cent. Afr. J. Med.* **17,** 108.

Jordan, P. (1963) *E. Afr. med. J.* **40,** 250.

Shiff, C. J., Clarke, V. de V., Evans, A. E. and Barnish, G. (1973), *Bull. Wld. Hlth. Org.* In Press.

Weber, M. C. (1973) *Cent. Afr. J. Med.* **19,** Supp. 9. 11.

Acknowledgments.

We are grateful to Dr. M. H. Webster, Secretary for Health, Rhodesia, for permission to submit this paper for publication.

Our thanks are also due to the Clinical Research Division, Sterling Drug (S.A.) (Pty.) Ltd., Johannesburg, for making the drug available.