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Follow-up of *Ascaris lumbricoides* and *Trichuris trichiura* infections in children living in a community treated with ivermectin at 3-monthly intervals

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Ivermectin treatment was administered every 3 months over a 1-year period (April 1993–April 1994) to the whole eligible population of a village in South Cameroon where both *Ascaris lumbricoides* and *Trichuris trichiura* were hyper-endemic. A parasitological stool examination was performed before each treatment. Thirty children, aged 5–15 years, were not only found egg-positive for *A. lumbricoides* and/or *T. trichiura* before the first treatment but were also each treated and examined in each treatment round. Among these children, the intensity of infection with *A. lumbricoides* decreased significantly following the first treatment but thereafter remained steady. In contrast, the repeated ivermectin treatments had no significant impact on the intensity of the *T. trichiura* infections or on the prevalence of infection with *T. trichiura* or *A. lumbricoides* among the 30 children.

Large-scale treatments with ivermectin (Mectizan®) have been widely developed for a decade to control onchocerciasis, and the drug is to be used in the near future in programmes for the control of lymphatic filariasis. Besides its action on filarial worms, ivermectin is effective against some intestinal nematodes. The results of several studies have demonstrated that it has a dramatic effect on *Ascaris lumbricoides* and *Strongyloides stercoralis*, for example, although it appears much less active against hookworm and *Trichuris trichiura* (Richard-Lenoble *et al.*, 1988; Freedman *et al.*, 1989; Naquira *et al.*, 1989; Testa *et al.*, 1990; Whitworth *et al.*, 1991; Njoo *et al.*, 1993; Behnke *et al.*, 1994; Datry *et al.*, 1994; Taticheff *et al.*, 1994; Marti *et al.*, 1996; Richard-Lenoble, 1998). However, most of these trials have been done in a medical environment and/or have only investigated the effect of a single dose. The impact of repeated ivermectin treatments on the prevalences and intensities of infection with intestinal nematodes in field conditions needs to be more accurately documented. The aim of the present field study was to evaluate the changes in the intensities of intestinal-nematode infections in children living in a village where 3-monthly ivermectin treatments were administered to the total eligible population for 1 year.

PATIENTS AND METHODS

The study was carried out in the village of Ngat (3°23′N, 11°34′E) in the Central prov-

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ince of Cameroon. This community, which had 788 residents in April 1993, is located 70 km south of Yaoundé, in an area of degraded forest. The climate is equatorial, with a long rainy season (September–mid-November) and a short rainy season (mid-March–June). Most of the residents are engaged in subsistence and cocoa farming. Early in 1993, all the residents aged ≥ 5 years were invited to participate in large-scale, 3-monthly treatments with ivermectin, scheduled for April 1993, July 1993, October 1993, January 1994 and April 1994. The population was clearly informed, and the protocol of the study was approved by the traditional authorities (i.e. the chief and village committee) as well as local health and national (Ministry of Public Health) authorities. The drug was given, at a dose of 200 μg/kg, to all who provided verbal informed consent and did not meet the usual exclusion criteria for treatment. Each child aged 5–15 years was only treated in the presence of one of his or her parents.

Just before each ivermectin distribution, one stool sample was collected from each child aged 5–15 years. These samples were then processed using the Kato–Katz method, and the eggs of all nematode species were counted.

As treatment coverage was not 100%, the intensities of infection with the commoner nematode species (in eggs/g faeces) were only compared for the children who were found to be infected with one of these species in April 1993 and who were each treated in every round (see Results). For each of the commoner nematode species, three indicators were calculated at each treatment round: the prevalence of infection (i.e. the percentage of the children found egg-positive); the median egg-count; and Williams' geometric mean (WM) of the egg counts. The latter, which is routinely used in epidemiological studies on onchocerciasis (Remme *et al.*, 1986), was calculated as:

$$e^{\Sigma[\ln(x+1)]/n} - 1$$

where x is the number of eggs/g, and n the number of children (Williams, 1937). The values for each round were then compared using commercial statistical software (SAS Institute, Cary, NC) and the McNemar test (for the proportions of positive children) or the Friedman two-way analysis of variance (for the intensity of infection ranked within subjects).

RESULTS

The treatment coverages (i.e. the ratio between the number of persons treated and the total population, including those individuals covered by the exclusion criteria) in April 1993, July 1993, October 1993, and January 1994 were 64.0%, 56.4%, 75.8% and 52.7%, respectively. Of the 76 children examined before the first treatment, 59.2% were egg-positive for *A. lumbricoides* and 80.3% for *T. trichiura*. Analysis of the results was confined to these two species, which were by far the most common (the prevalence of hookworms in the area was very low), and the 30 children who were initially found positive for *A. lumbricoides* and/or *T. trichiura* and who participated in all the five examinations and treatments from April 1993 to April 1994. These 30 subjects (16 boys and 14 girls, mean age = 9.1 years) were all, in fact, found egg-positive for *T. trichiura* before the first treatment round (with median and WM counts of 3360 and 3536 eggs/g, respectively), and 21 (70%) were also egg-positive for *A. lumbricoides* at that time (with median and WM counts of 8676 and 1258 eggs/g, respectively).

The Table shows the results of the successive stool examinations of the 30 subjects. No significant change was recorded between the rounds in the prevalences of *A. lumbricoides* or *T. trichiura*. The mean counts of *A. lumbricoides* eggs decreased markedly after the first treatment (Friedman's $\chi^2 = 18.0$; $P < 0.001$) but then remained steady. Ivermectin treatment had no significant effect on the intensity of infection with *T. trichiura* among the 30 subjects, the egg counts for this species remaining similar at each treatment round (Friedman's $\chi^2 = 6.1$; $P > 0.18$).

TABLE

Prevalences and intensities of infection with Ascaris lumbricoides *and* Trichuris trichiura *in the 30 children (5–15 years of age) examined and treated with ivermectin (200 μg/kg) at each round*

Parasite	*Parameter*	*April 1993*	*July 1993*	*October 1993*	*January 1994*	*April 1994*
Ascaris lumbricoides	Prevalence and (95% confidence interval) (%)	70.0 (50.6–85.3)	60.0 (40.6–77.3)	70.0 (50.6–85.3)	63.3 (43.9–80.1)	63.3 (43.9–80.1)
	Median intensity and (interquartile range) (eggs/g)	18 720 (0–41 088)	1848 (0–5112)	1368 (0–11 520)	888 (0–5688)	852 (0–3984)
	Williams' mean intensity and (S.D.) (eggs/g)	1258 (121)	157 (70)	333 (61)	165 (67)	118 (54)
Trichuris trichiura	Prevalence and (95% confidence interval) (%)	100 (88.4–100)	96.7 (82.8–99.9)	100 (88.4–100)	100 (88.4–100)	100 (88.4–100)
	Median intensity and (interquartile range) (eggs/g)	3432 (2040–6000)	2568 (1248–6288)	3180 (1056–5928)	3336 (2208–7704)	3672 (1992–7536)
	Williams' mean intensity and (S.D.) (eggs/g)	3536 (2)	2021 (5)	2286 (3)	3287 (3)	3385 (2)

DISCUSSION

The present results provide data on the impact of ivermectin when the drug is given in the field (i.e. in a context of ongoing re-infection) but in otherwise apparently good conditions for the reduction of transmission intensity [with treatment proposed to the total eligible population and given at short (3-monthly) intervals]. Although the number of children successfully followed-up was small, the results clearly demonstrate that, even in field conditions, repeated ivermectin treatments bring about a reduction of some 70%–90% in the intensity of infections with *Ascaris*. This finding is of major importance because the level of morbidity attributable to *Ascaris* infection, like that caused by most helminths, correlates with worm burden (Chan *et al.*, 1994). However, the treatments did not reduce the prevalence of *Ascaris* among children who were infected before the first treatment. This failure to clear infection and/or prevent re-infection is probably a reflection of the persistence of *Ascaris* eggs in the environment, in a reservoir partially maintained by eggs excreted by untreated but infected individuals (particularly children aged < 5 years). There have been several similar trials to investigate the effect of repeated ivermectin treatments on the level of *Ascaris* infection in the field. In some of these, a reduction in prevalence was observed for at least 3 months post-treatment (Whitworth *et al.*, 1991; Taticheff *et al.*, 1994) whereas in others, as in the present study, no significant change was reported (Behnke *et al.*, 1994). This discrepancy might be explained, at least partially, by differences either in the initial levels of endemicity of the parasite or in the study protocols. The present observation that ivermectin had little long-term effect on *T. trichiura* confirms the results of earlier studies (Richard-Lenoble *et al.*, 1988; Whitworth *et al.*, 1991; Behnke *et al.*, 1994; Marti *et al.*, 1996).

Anderson and Medley (1985) suggested that ivermectin should be distributed every 2–6 months to control the morbidity associated with *Ascaris*. Further field studies need to be carried out in order to evaluate, in various epidemiological situations, the impact of 6-monthly (or even less frequent) treatments with ivermectin on the burden of this parasite.

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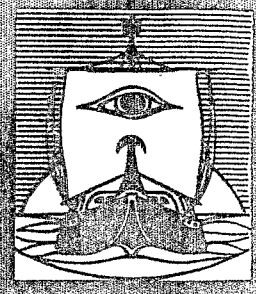
VOLUME 95 NUMBER 4 JUNE 2001



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