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The efficacy and residual life span of two alphacypermethrin insecticide formulations (Fendona 6% Suspension Concentrate and Fendona Dry 15%) treated on mosquito bed nets

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Objective: To compare the effects of mosquito nets treated with two formulations of alpha-cypermethrin insecticide with a view to recommending the most appropriate formulation for use to treat mosquito nets.

Design: Assessment of insecticide potency under conditions of ordinary use.

Setting: Chilonga rural irrigation community in south east lowveld Zimbabwe, a holoendemic area of year round malaria transmission.

Subjects: Convenience sample of 20 household heads (volunteers) was issued with treated mosquito nets.

Intervention: Following mosquito net treatment and distribution, bioassay tests were carried out monthly for a period of six months on insecticide and placebo treated nets. Questionnaires were administered once, one month post treatment of nets.

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Main Outcome Measures: Median mosquito knock down times of mosquitoes exposed to insecticide treated nets and community attitude towards the use of insecticide treated nets.

Results: Average time taken to knock down the median mosquito progressed from 2.3 minutes to 13.0 minutes for Fendona Dry 15% and from 4.1 minutes to 7.8 minutes for Fendona 6% SC over the six month period. The average time taken to knock down the median mosquito three months post-washing were 13.0 minutes and 7.4 minutes for Fendona Dry 15% and Fendona 6% SC respectively as against more than 30 minutes in controls. Both insecticides exhibited some wash resistance properties. The side effects reported were sneezing, itching, skin rash and smelling. Questionnaire data suggested that alphacypermethrin treated mosquito nets were welcomed.

Conclusions: Both insecticide formulations proved to be suitable candidates. This was because of their insecticidal potency, wash resistance properties and acceptance by the community.

Introduction

Zimbabwe has a National Malaria Control Programme (NMCP) that dates back to 1949. The major strategy for controlling malaria is indoor spraying of residual insecticides, supported by clinical case management. Due to the escalating cost of the insecticide and decreasing government resources, the spraying campaign has been curtailed and not all rural areas are sprayed each year. Spraying is now limited to areas where malaria is holoendemic and areas that are at risk for epidemic malaria during the peak season (mesoendemic).

Use of insecticide treated bed nets is a useful adjunct to the spraying programme.¹⁻³ Alternatives to spraying campaigns have been sought. Non Governmental Organisations (NGO) such as the Population Services International have embarked on a massive mosquito net promotion using their expertise in sales and marketing. At the same time some local companies have come up with different formulations of insecticides meant for mosquito net treatment. Studies carried out in Zimbabwe have shown that mosquito nets are not being used on a large scale.^{4,5} The cost of the nets and insecticides for re-treatment was found to be the main limiting factor.⁶

Among those communities that have purchased insecticide treated nets through NGOs promotion, the sustainability of this new malaria control technology in rural malaria endemic areas through provision of easily accessible, safe, affordable and easy to use insecticides for re-treatment of their bed nets needs to be investigated. It is against this background that two formulations of alphacypermethrin insecticides were evaluated with a view to recommending their use by the rural community in malaria endemic areas.

Materials and Methods

Study Area.

The study was conducted in Chilonga rural irrigation village (31°25' E; 21°10' S) in Chiredzi District, south east of Masvingo Province, Zimbabwe. The population consists primarily of the Shangani people who also speak fluent Shona.

Mosquitoes.

Laboratory bred, two to five day old un-fed *Anopheles arabiensis* (KGB strain from London School of Tropical Medicine and Hygiene) were used.

Mosquito Nets.

White polyester three-quarter (9.5m²) and double (12m²) sized mosquito nets with a denier of 100 were used. The specifications were according to Emnet Private Limited, the local mosquito net manufacturing company.

Mosquito Net Treatment.

The two formulations of alpha-cypermethrin used were Fendona Dry 15% and Fendona 6% SC. The recommended target dose for both formulations was 30 mg/m². The three quarter and double mosquito nets had water absorbency capacities of 350ml and 500ml respectively. A total of 4.75ml (diluted with 345.25ml of water) and 6ml (diluted with 494ml of water) of Fendona 6% SC were used to treat each of the three-quarter and double mosquito nets respectively. Twenty nine tablets (dissolved in 344ml of water) and 36 tablets (dissolved in 491.5ml of water) of Fendona Dry 15% were used to treat each of the three quarter and double mosquito nets respectively.

A convenience sample of 20 study households was selected from Chilonga irrigation village. Treatment of mosquito nets was done at a central location within the village. The treatment exercise was completely blind to mosquito net recipients and our staff who would conduct the bioassay tests. The treatment was done soon after mosquito nets were issued to the household heads. For consistency, a trained individual from the local community treated the nets. After net dipping in a clean plastic bowl the nets were spread on a non used clean plastic sheet to dry before being handed over to the individuals. The individual net users were urged to use the net properly and every night for a period of six months after a demonstration on how to use the mosquito nets was done. Eight and six individuals received mosquito nets treated with Fendona Dry 15% and Fendona 6% SC respectively.

At the same time, another six mosquito nets were placebo treated with a powdered milk solution. The mosquito net recipients did not know the type of insecticide treatment their nets had received. A record indicating the type of insecticide treatment and the recipient was kept, unknown

to individuals who would perform the bioassay tests at a later stage of the study.

Bioassay Tests.

Bioassay tests were carried out following the procedure recommended by WHO⁷ and used by some other authors.⁸ This was done by individuals who did not know the type of treatments of each mosquito net. In this study three standard WHO cones were used per net. The first cone was fixed at the top of the net. The second was fixed at the middle and the third at the bottom entry point of the net. A total of 11 mosquitoes were introduced into each cone. The knock-down times for the first, sixth and 11th mosquitoes were recorded. Whenever the time taken to knock down the 11th mosquito exceeded 30 minutes, the tests were stopped. Bioassays were conducted two weeks, and three, four, five and six months post mosquito net treatment. It was anticipated that bioassays would be conducted during the first and second months after net treatment. Some logistical problems encountered deprived us of this chance.

Ten mosquito nets (four previously treated with Fendona Dry 15%, the other three previously treated with Fendona 6% SC and the remaining three previously placebo treated) were washed after being in use for three months. Under supervision, the community washed the nets once during the study period using the local common "blue soap" and plenty of bore-hole water to rinse so as to remove all traces of the alkaline soap and in the normal way that they would do when washing their clothing.

Acceptability of Alpha-cypermethrin Formulations by the Respondents.

Structured questionnaires were administered in the Shona language to all the 20 household heads issued with nets, one month post treatment of mosquito nets. The questions asked gathered information on the side effects experienced when respondents slept under treated nets, frequency of washing preferred and needs for re-treatment, willingness to pay for the net and insecticide and other problems encountered during the course of net usage.

Ethical Considerations.

Verbal informed consent was sought from the study participants after explaining to them the objectives and activities of our study. Those who did not allow us to enter their bedrooms during bioassay tests were not included in the study. The study participants were informed that they were free to withdraw from the study whenever they wanted.

Statistical Analysis.

The Mann Whitney U-test was used to compare results for unwashed Fendona Dry 15% and Fendona 6% SC mosquito nets whilst the Wilcoxon Sign Rank test was used to compare washed and unwashed mosquito nets treated with Fendona Dry 15% and Fendona 6% SC formulations.

Results

Bioassay Tests.

Results for the time taken to knock down the median mosquitoes are shown in Table I.

Table I: Time taken to knock down the median mosquitoes.

Insecticide Formulation	Median mosquito knock down times (minutes)							
	2 weeks	3 months	4 months		5 months		6 months	
			Un- Washed	Un- washed	Un- Washed	Un- washed	Un- Washed	Un- washed
Fendona Dry 15%	2.3	7.9	5.0	4.5	3.7	2.3	13.0	13.0
Fendona 6% SC	4.1	8.0	7.0	3.8	2.0	4.9	7.4	7.8
Control	>30	>30	>30	>30	>30	>30	>30	>30

The time taken to knock down the median mosquito (sixth mosquito) in the placebo treated nets remained above 30 minutes although on four occasions the first mosquito was knocked down within two minutes of introduction into the cones. This could have been due to handling of the mosquitoes. No significant differences could be found between unwashed mosquito nets treated with Fendona Dry 15% and Fendona 6% SC ($p < 0.001$) and also between the washed and unwashed Fendona Dry 15% ($p < 0.05$) treated mosquito nets and, between washed and unwashed Fendona 6% SC ($p < 0.05$) treated mosquito nets. The two formulations of the insecticide exhibited the same characteristics. Washing of mosquito nets did not reduce the effectiveness of the insecticides.

Side Effects Experienced.

The side effects reported for Fendona Dry 15% were sneezing and itching (one), sneezing only (one) and skin rash (one). Three and one individual(s) using Fendona 6% SC reported itching only and smelling respectively. In the control group the side effects reported were sneezing (one), itching (one) and skin rash (one). The rest of the respondents did not experience any side effects when using mosquito nets treated with Fendona Dry 15% (five), Fendona 6% SC (two) and powdered milk (three).

Daily Use of Nets.

None of the respondents encountered problems in fitting their mosquito nets. The control group used their nets daily as compared to the treatment groups. Five individuals using Fendona Dry 15% and three individuals using Fendona 6% SC treated nets had at one stage slept outside their nets. Only one person gave the reasons for not using the nets as sneezing and itching due to Fendona Dry 15%. The others were, either away from home visiting relatives (two), guarding crops in the fields (two) or just felt uncomfortable sleeping under mosquito nets (three). None had taken the nets with them to the fields since they did not sleep there.

Frequency of Mosquito Net Washing.

Most of the respondents had the desire to wash their nets irrespective of the insecticide used. Table II shows information pertaining to the frequency at which individuals want to wash their mosquito nets over a twelve month period.

Table II: Number of individuals expressing the frequency at which they want to wash their mosquito nets.

Frequency of washing over 12 months Months	Treatment			All
	Fendona Dry 15%	Fendona 6% SC	Control	
1	2	0	0	2
2	2	0	2	4
3	0	1	1	2
4	1	1	0	2
5 and above	3	4	3	10

Re-treatment of Nets.

Seventeen people were prepared to have their nets re-treated whilst two people and a single individual using nets treated with Fendona Dry 15% and Fendona 6% SC respectively were not willing to have their nets re-treated. Nineteen people were prepared to pay for re-treatment costs ranging from US\$0.53 to US\$5.00 with an average of US\$1.60. Most of the respondents acknowledged the safety of the insecticide to humans.

Discussion

The use of time taken to knock down the median mosquito is a new concept not yet widely used and was adopted during the WHO Informal Consultation on the "Evaluation and Testing of Insecticides."⁷

Using the same approach a previous study⁸ found even higher values for the time taken to knockdown the median mosquito as compared to this present study. This shows that the two formulations of alpha-cypermethrin tested have a higher insecticidal power and therefore are both ideal for treatment of nets in malaria control programmes. Since they exhibited the same insecticidal power any one of the two could be used. It is, therefore, recommended that packaging of both formulations could be improved in such a way that they are easy to use and also made readily accessible to the rural community in malaria endemic areas.

The continued effectiveness of both insecticide formulations even after a single wash has been reported⁹ and this is an added advantage considering that in Zimbabwe malaria transmission in general occurs for almost six months.

The tendency expressed by the community for frequent washing of mosquito nets may be attributed to the type of housing and the traditional paraffin night lighting facilities that emit a lot of black smoke. A similar tendency for frequent washing of nets observed in Tanzania was also found to be related to the type of housing.¹⁰ Washing of nets treated with alpha-cypermethrin was shown to have little effects on the potency of the insecticide since mosquitoes continued to be knocked down after a single wash. Therefore the rate at which the community preferred to wash their nets is compatible with continued effectiveness as long as washing is limited to three washes every six months, or re-

treatment is done at least once in six months. The limiting factor here could be the cost of re-treating the nets. Although the community could part with at most US\$5.00, it has been observed that although rural households may have the equivalent of only a few dollars of disposable income per year, a cash payment of US\$3.00 to US\$5.00 may be difficult to meet.¹¹ In this study the reason why they could afford a maximum of US\$5.00 is that the study community is always involved in agricultural income generating projects that bring in some extra cash as compared to the surrounding dry rural and other similar areas in Zimbabwe. The number of people willing to have their mosquito nets re-treated was encouraging. This indicates that the community is committed to fighting against the malaria disease.

No serious side effects were reported. Most of the symptoms described by the net users were temporary in nature and these have been found to be common when using most of the pyrethroid insecticides.^{9,12} The side effects reported for the placebo treated mosquito nets might have emanated from the general belief that the use of mosquito nets causes some form of discomfort especially among a people who traditionally did not use nets.⁶

The daily use of treated mosquito nets was generally pleasing although at some stage the net users slept out of the nets. This is not surprising and is also so common during the first days of mosquito net use among a community that traditionally did not use the nets.⁶ However the community in this study gradually got used to sleeping under the treated mosquito nets without feeling any discomfort.

Conclusion

Both insecticide formulations are recommended for use in treating mosquito nets because of their effectiveness in killing mosquitoes, wash resistance properties and general acceptance by the rural community. Packaging of the insecticides could be improved so that the insecticides are accessible, safe and easy to use by the community living in malaria endemic regions of Zimbabwe.

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REVIEW ARTICLES

An update on human bartonellosis

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The data available on *Bartonella* species has increased rapidly in the last decade with 12 new species and subspecies being described and bartonellas being found to be associated with an increasing spectrum of clinical syndromes in immunocompetent and immunocompromised patients. In addition *B. weissii* is found in cats. This rapid expansion of knowledge has come about with the development of new culture and molecular biology techniques to isolate and identify the organisms. Much of the information on the bartonellas and the emerging infectious diseases they cause has been derived from the USA and Europe although there is growing evidence that the organisms may be important pathogens in other regions including southern Africa. In this review we describe the bacteriology, epidemiology, clinical and laboratory signs, diagnosis and treatment of *bartonella* infections and the most recent data on bartonellas in southern Africa.

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Introduction

The genus *Bartonella* contains Gram-negative bacteria and lies among a large group of plant-associated bacteria in the alpha-2 subdivision of the *Proteobacteria*. Until

recently, *B. bacilliformis*, the agent of Carrion's disease in South America, was the only species in the genus. In 1993, on the basis of DNA relatedness and 16S rRNA gene sequence data, the genus *Rochalimaea* containing the species *R. quintana*, *R. henselae*, *R. vinsonii* and *R.*

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