Efficacy of a Combination Long Lasting Insecticidal Net (PermaNet® 3.0) Against Pyrethroid Resistant Anopheles Gambiae S.S and Culex Quinquefasciatus: An Experimental Hut Trial in Nigeria

Adeogun A.O.1,2, Olojede J.B.3, Amahob C.2, Oduola A. O.2 and Awolola, T.S.1

1. Molecular Entomology and Vector Control Research Laboratory, Nigerian Institute of Medical Research, Lagos. Nigeria
2. Department of Zoology, University of Ibadan, Ibadan, Nigeria
3. National Malaria and Vector Control Program, Abuja, Nigeria

BACKGROUND:

Insecticide resistance in the African malaria mosquitoes presents a major challenge facing malaria control. Newer methods of preserving the efficacy of available public health insecticides need to be put in place. PermaNet® 3.0, a new long lasting insecticidal net (LLIN), was designed to give integrated efficacy against pyrethroid-resistant malaria vectors. This mosaic LLIN combines deltamethrin coated polyester side panels and deltamethrin with piperonyl butoxide (PBO) incorporated polyethylene roof. There are currently no guidelines for evaluating products that have an effect on insecticide resistant vectors. A practical approach is to compare the efficacy of PermaNet® 3.0 with LLINs that received full WHOES recommendation. At present, only PermaNet 2.0 and Olyset® nets have met these criteria (1-2), with the remaining nets given a full recommendation but based only on equivalency with PermaNet 2.0 (1). Aside from a parallel study in Kenya (2), previous field evaluations of PermaNet 3.0 were made in comparison with PermaNet 2.0, a product from the same manufacturer but not on deltamethrin alone (4-5). Here we compared the performance of PermaNet 3.0 with permethrin-impregnated Olyset® nets in experimental hut in north-central Nigeria.

MATERIAL AND METHODS

The nets were evaluated in experimental huts (Figure 1) located at the Nigerian Institute of Medical Research field station at New Ikusu (9°53'N; 4°31'E). The malaria mosquito Anopheles gambiae s.s. in the area exhibits a high level of pyrethroid resistance, which is dominant and of mixed origin. The experimental huts were built on concrete floors following the pattern of huts used in West Africa. The style of the huts simulates domestic habitations and p.m. poorly built with the frond side facing perennial mosquito-breeding sites. Prior to the field test, a subset of net samples were washed using standard WHO washing protocols and bioefficacy evaluations were conducted with resistant strains of the vector Anopheles gambiae s.s. and Culex quinquefasciatus. Incubation of Olyset samples was adapted from the previous phase study (x) with 0.4 cm cut each net. A polyester net treated with deltamethrin and washed until just before exhaustion was used as the positive control. Six nets were used per treatment arm and the treatment areas were rotated each week among the huts, with rotation of adult male volunteers who slept under the nets each night. The 12 weeks Latin Square design was established from WHO guidelines for phase 2 field trial (2). Field efficacy was expressed in terms of mosquito mortality in hut entry, blood-feeding inhibition, induced exophily and mortality.

RESULTS AND DISCUSSION:

Laboratory cone bioassays using resistant A. gambiae s.s. prior to and after experimental hut evaluations showed high mortality (>75%) in PermaNet 3.0 and was consistent with the WHO data. Increased bioefficacy likely due to the synergistic effect of PBO and deltamethrin was observed from in situ bioassays, with significant mortality rate of resistant A. gambiae s.s. recorded following exposure to the roof panel. This property was however lost with C. quinquefasciatus after 20 washes. Sufficient time was given between washing and bioassay of Olyset net samples but a decline was observed in the bioefficacy of Olyset nets after 20 washes which was consistent with data from our previous study on wash resistance of Olyset nets (6).

Analysis of the 12 weeks experiment hut data showed that PermaNet 3.0 induced a level of deterrence against A. gambiae and C. quinquefasciatus similar to that of the Olyset net. Both nets still deterred net entry after 28 successive washes (Figure 2). The similarity in deterrence of both nets could explain the negligible difference in the overall number of mosquito collected in the different treatment arms.

CONCLUSION:

This study showed that PermaNet 3.0 could provide additional protection in terms of reduction in blood feeding and increases in mosquito mortality but has no obvious comparative advantage over the Olyset net in terms of deterrence in hut entry and induced exophily.

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