

Piperonyl Butoxide: An Enhancing Arsenal for an Adomant Foe

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Abstract

Vector control using treated nets and recently industrially long lasting insecticidal nets (LLINs) have played a vital role in malaria control globally. The emergence of insecticides resistance among malaria vector against pyrethroids has raised a concern over achieved a milestone. Different insecticides resistance mechanisms have evolved against pyrethroids. This has given mosquitoes an opportunity to increase survivor fitness. The incorporation of synergistic effect of Piperonyl Butoxide (PBO) in LLINs has shown a significant impact in areas with pyrethroid resistant malaria vectors than LLIN without PBO. LLINs with PBO for management of resistance can revive pyrethroid strength against resistant malaria vectors. There is a necessity for National malaria control and other NGOs in Africa distributing LLINs to distribute nets with pyrethroids and PBO.

Keywords: Resistance; *Anopheles gambiae*; Malaria; Piperonyl butoxide; LLINs

Abbreviations: Indoor Residual Spray; LLINs: Long Lasting Insecticidal Nets; NGOs: Non-Governmental Organisations; PBO: Piperonyl Butoxide

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Background

In most malaria endemic countries, long-lasting insecticidal nets (LLINs) are known to have an impact in malaria control by reducing mosquitoes survival fitness [1]. Malaria morbidity and mortality have declined from 1,500,000 to 480,000 per year from 2000 to date [2]. Malaria decline has been attributed to the use of LLINs distribution across Africa and rest of the world (**Figure 1**). Exposure of mosquitoes to LLINs and indoor residual spraying (IRS) insecticides significantly increased mortality for mosquitoes, women and children survivorship [3]. Due to increased mortality, mosquitoes evolved mechanisms to enhance survivor for the fittest of forthcoming generations. Mosquitoes developed cuticular resistance to insecticides, Knockdown resistance through Sodium ions channel and metabolic resistance [4,5]. These mechanisms have led to increased tolerance of mosquitoes to pyrethroids insecticides [4,5]. The insecticides resistance selection pressure among vectors would increase as exposure to insecticides treated material is extended [6]. At present, LLINs are no longer showing the impact it has shown few decades ago in Africa where there has been reports of rapid decline of child mortality and morbidity [7] due to mosquitoes insecticides resistance problem [8-11]. Changing of IRS compound have caused some resistant mosquitoes to be susceptible but with time they have built

resistance [9,12-15]. Insecticides detoxification enzymes have been expressed in higher level and caused insecticides tolerance which increases the survivorship of mosquitoes and increase the disease risk [16]. There are also reports showing that, the efficacy of pyrethroid alone treated nets have declined drastically in areas with high pyrethroid resistant mosquito populations [17]. This may be a roadblock to sustain malaria control and initiate elimination by most malaria endemic African countries and transmission may not be interrupted despite large scale distribution of LLINs impregnated with pyrethroids alone [18].

The incorporation of a Synergistic effect of Piperonyl Butoxide (PBO) on roof and side panels of LLINs have improved the efficacy

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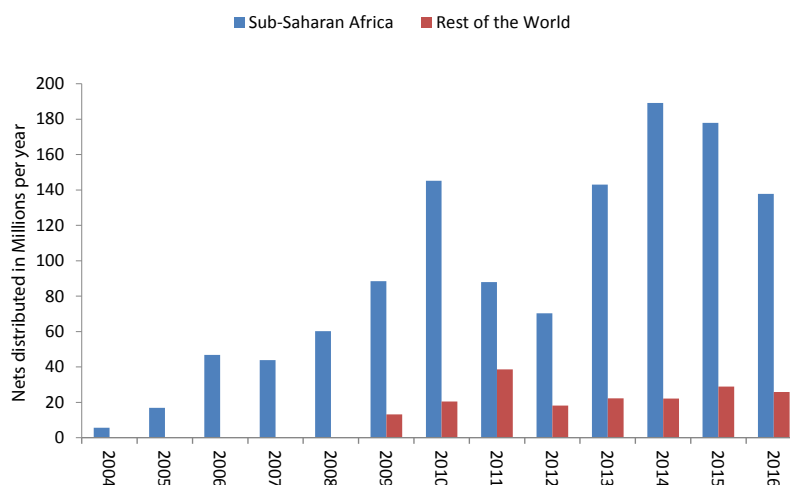


Figure 1 A figure showing the LLINs distribution globally (Source, WHO net mapping project, 2016).

of LLINs against resistant mosquitoes [19-22]. It has a potency of increasing cuticular penetration of insecticides and increase mosquito susceptibility [23]. PBO has played a role in inhibiting esterases and P450s enzymes and their role in insecticide oxidative detoxification in insects [19]. LLINs with PBO have shown more efficacy against pyrethroid resistant mosquitoes than nets with pyrethroids only [21]. Metabolic resistant is widely spread in malaria vectors across sub-Saharan Africa and PBO could enhance the performance of LLINs by increasing the susceptibility status of the vectors to pyrethroids [21,22]. PBO works by inhibiting the activity of enzymes in insect body [24]. However, incorporation of PBO synergist in LLINs, has been reported to restore the efficacy of pyrethroids in the areas with high pyrethroid resistant population [21,22]. The LLINs with PBO have proved to be safe and no any side effect for human beings [25-27].

Currently, LLINs have an improved synergistic effect of PBO on top or on top and all side panels for management of insecticide resistance [20,22].

What is the way forward

Malaria endemic areas government collectively should order their national malaria control programmes, donors and NGOs during campaigns for scaling up LLINs, its mandatory to use nets with PBO as synergist to pyrethroids either in one side or all

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sides of the net. Communities should be provided with names of available net brands with PBO as synergist for more awareness during purchasing. The information on benefits of PBO in nets should be clearly addressed.

Conclusion

Based on information gathered from different sources, the use of LLINs with PBO seems promising in increasing the susceptibility of malaria vectors and hence to revive malaria control elimination program in many malaria endemic sub-Saharan countries with pyrethroids based LLINs interventions.

Contributors

EJK conceived and drafted this commentary, HDM GM and DY revised critically and improved this commentary. All authors we have agreed upon its submission.

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Ethics Committee Approval

This commentary was approved by Research and publication committee of Tropical Pesticides research Institute (TPRI)

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