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REVIEW

Culminating anti-malaria efforts at long lasting insecticidal net?

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LLIN;
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Summary
Background: Long-lasting insecticidal nets (LLINs) are a primary method in malaria control efforts. However, a decline in the biological efficacy and physical integrity over a period of comparatively lesser time than claimed, waning of naturally acquired immunity among regular users and misuse of LLINs are serious concerns.
Search and selection of literature: The literature for the current review was searched in PubMed, SCOPUS Database and Google using combined search strings of related key-words. Literature with sufficient data and information on the current subject was selected to reach a valid conclusion.
Findings: The World Health Organization (WHO) has emphasized that LLINs should be considered a public good for people inhabiting malaria endemic settings. LLINs exhibited a cumulative effect on the vector density and may force anthropophilic mosquito vectors to find alternative animal hosts for blood meal. However, the physical integrity and biological activity of LLINs declines faster than the anticipated time due to different operational conditions and the spread of insecticide resistance. LLINs have been successful in reducing malaria incidences by either reducing or not allowing human exposure to the vector mosquitoes, but at the same time, LLINs debilitate the natural protective immunity against malaria parasite. Misuse of LLINs for deviant purposes is common and is a serious environmental concern, as people believe that traditional methods of prevention against malaria that have enabled them to survive through a long time are effective and sufficient. Moreover, people are often ill-informed regarding the toxic effects of LLINs.
Conclusions: Specific criteria for determining the serviceable life and guidelines on the safe washing and disposal of LLINs need to be developed, kept well-informed and closely monitored. Malaria case management, environment management and

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community awareness to reduce the misuse of LLINs are crucial. Focused research on developing effective anti-malarial drugs, vaccines and new insecticides to reduce resistance is imperative to tackle malaria in the future.

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Introduction

Even after tremendous control efforts, malaria still remains a major cause of mortality in many Afro-Asian countries and carries a significant economic burden in the nations where it is endemic [1]. The malaria parasite *Plasmodium* has separate development stages in the human host and *Anopheles* mosquito. Malaria was once spread throughout most of the world; however, due to changes in the house designs, clearing of the breeding sites and the use of DDT after the Second World War, malaria was extinguished from the majority of northern countries. The concerted efforts to control malaria in endemic countries and step toward complete elimination in comparatively less endemic countries largely hinges on the latest effective tools available for prevention and treatment [2]. Malaria vector intervention through the use of long lasting insecticidal nets (LLINs) is considered a primary control method, and it is emphasized that LLINs should be considered a public good for people inhabiting malaria endemic settings.

The use of LLINs provides a physical barrier that reduces human-mosquito contact; furthermore, the insecticidal and repellent activity of the insecticide incorporated into the LLIN fiber protects the users as well as non-users by providing community protection through spatial effects [3]. LLINs used at the community-wide level can exhibit cumulative effects on vector density, survival and longevity over a large area and may force *Anopheles* mosquitoes to find alternative animal hosts and ultimately reduce human malaria transmission [4]. Many studies across the world have revealed that LLINs were able to reduce the malaria burden and significantly reduce the uncomplicated malarial episodes in areas of both stable and unstable malaria transmission [3,5—8].

The introduction of insecticide treated bednets (ITNs), which were developed during the 1980s to prevent malaria in the Roll Back Malaria (RBM) program, proved highly effective in reducing malaria-related morbidity and mortality. The effectiveness of ITNs in reducing malaria was demonstrated for nets and cloths dipped in the insecticide solutions [6,9—11]. However, ITNs did not prove to be practical in the field because getting the net properly re-impregnated after 6—12 months was difficult. Further, the availability of insecticides when needed and the cost of the insecticides emerged as critical issues; the retreatment rates were reduced exorbitantly when people had to pay for the insecticides [12—15]. The LLINs were developed as a response to various problems associate with ITNs, and had several advantages over the latter. These were ready-to-use pyrethroid-treated nets that resisted washings and did not require re-impregnation for up to several years. Recent studies have suggested that the effective life of LLINs varied from two to seven years under different conditions [16—18].