The applicability of available technologies for adaptive integrated malaria vector management in Africa: LSM in Urban Malindi, Kenya

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Introduction
Several tools are in use to control malaria vectors in Africa.1,2. These tools include use of Insecticide Treated Nets (ITN), larval control, Indoor residual Spraying (IRS) and Environmental Management (EM). Vector control interventions against adult mosquitoes using ITNs or IRS, combined with improved access to effective diagnosis and treatment, have enormous potential in reducing malaria morbidity and mortality.3 Although these tools have been shown to be useful in impacting malaria transmission, they have been used in a rational combination in a few countries where they have greatly reduced malaria transmission. Nevertheless, a more efficient, effective and ecologically sound approach could be achieved through a combination of approaches, the IVM strategy; having decisions increasingly based on local evidence; using a range of interventions; considering multiple diseases; and harnessing the existing systems and local human resource. The main goal is to improve human health through reduction of malaria by using ecologically and environmentally friendly malaria control approaches.

Methods
Urban Malindi was selected for the implementation of IVM approaches as alternative vector control tools. Scaling up of different malaria vector interventions techniques was based on ecological, entomological and epidemiological assessments. Three pillars of IVM approaches were adopted; scaling of bednets (LLINs), control of mosquito immature using microbial larvicides and/or botanicals, and environmental management (draining and filling) in addition to active community participation.

Microbial larvicides (Bacillus thuringiensis var. israelensis (Bti) and Bacillus sphaericus (Bs)) were applied weekly for one year in all sites and then regularly on a monthly basis through community based delivery system. Vector surveillance activities relied on 2 major activities; 1) mapping and surveillance of potential larval habitats, and 2) monitoring on adult mosquito densities inside houses. Local community resource persons (CORPs) or mosquito scouts were trained in basic simple tools for monitoring mosquitoes, guidance on environmental management (EM), correct use of bednets and advocacy in order scaling them up. Additionally, we have tested the effectiveness of crude neem products (Azadirachta indica) for larvicidal activity.

Result
Environmental management (filling, draining and water management) was successfully conducted by the community.

Overall, a significant reduction in Anopheline larvae was 55.7% in Malindi (Fig 1). Subsequently, overall reduction in Anopheles resting indoors was 60.9%.

Fewer Anopheles mosquitoes were observed and none of them was found positive for Plasmodium falciparum circumsporozoites suggesting a reduction in human -vector contact and transmission.

A high larval mortality of more than 90% was recorded when using crude neem extract. Larval habitats treated with a single application of crude neem products were free of larvae after 3-4 weeks.

Epidemiological assessment of malaria cases show a 62% reduction

Discussion
Our findings using IVM approach through routine application of microbial larvicides, EM, scaling of ITNs in combination with active community participation resulted in dramatic reduction in larval and adult mosquito density and subsequently on malaria morbidity and mortality.3,4 These non-chemical malaria control approaches were found to be highly effective. This coupled with a comprehensive monitoring and surveillance system for entomological, epidemiological and meteorological information will help guide decision making process for effective vector control.

In order to monitor breeding sites and effectively tackle them, regular assessment of larval development and updated larval distribution maps in real time is necessary. Our results show that crude neem extract products have high larvicidal activity against mosquito larvae. These results are very promising in creating new effective and affordable approaches to the control of vector mosquitoes and can be utilised holistically for sustainable development.5,6. Active participation of the communities in mosquito and malaria control is the cornerstone of an effective IVM.6,7,8.

Conclusion
Our results demonstrate success with bienvironmental malaria control in urban settings. Large scale application with microbial larvicides and larval source management has the potential to be integrated into control programmes using ITN/LLINs or IRS and can be considered in the management of insecticide resistance and outdoor transmission. Further the development of innovative botanicals such as neem products for the control of vectors of diseases is required.

References: