Clinical Sciences Research and Reports

Short Communication ISSN: 2516-709X

Two major porous barriers: How to seal the pores to achieve malaria elimination in Kenya

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Abstract

Having a malaria-free world is a bold possibility. Target 3.3 of the sustainable development goals calls for an end to malaria and other communicable diseases by 2030. Although progress has been made to improve the health of many people, advances seem to have stalled in the fight against malaria. This stagnation has been majorly attributed to the emergence of insecticide and drug resistance malaria vector and parasite. Despite the tremendous efforts made by the Kenyan National Malaria Control and Prevention Programme in collaboration with other key stakeholders in malaria control, there are still some parts of the country, particularly around Lake Victoria basin, where prevalence of malaria is very high and heterogenous. With the modern malaria control strategies relying on pyrethroid-based insecticides and artemisinin-based combination therapies (ACTs) and there being increasing resistance of malaria vectors to pyrethroids and its products as well as potential resistance to ACTs, the pre-elimination target is at risk and may not be achieved unless other novel products are developed, evaluated and rolled out. This will require sustained resources mobilization especially domestic financing for delivery of deliberate, targeted prevention and control approaches as well as close collaboration and active participation between government agencies and key partners including the affected communities and academic institutions mainly universities.

Introduction

The optimism that malaria elimination is an achievable has been high and many countries are already on the path to malaria pre-elimination path with a few of them eliminating malaria and many more marked for elimination target by WHO [1]. Target 3.3 of the sustainable development goals calls for an end by 2030, to malaria and other communicable diseases. With barely a decade to that target, the tremendous gains made in malaria burden reduction is facing a serious threat from emergence and rapidly increasing insecticide resistance and a potential threat of drug resistance [2]. Is the vector and the parasite evolving faster than the pace of research and development for new and effective interventions to prevent and manage malaria in endemic countries?

Although malaria burden has shown significant decline over the last two decades [3], recent report indicate that malaria incidences have picked and are increasing in some countries [4]. This increment is threatening the gains achieved by integrated strategies employed to reduce malaria burden not only in Kenya, but also in other African countries where malaria is endemic. So, what is breaching the once effective barriers to prevent malaria transmission and reduce malaria incidences? Well, although there are likely multiple factors influencing the slowed progress in decreasing malaria burden, the main driver on the seat is the emergence and rapidly increasing insecticide-resistant vectors [5] and drug resistant malaria parasite strains [6,7]. If not managed promptly and decisively, the chemical and drug resistance is making malaria vector control and case management barriers porous and the gains achieved in reducing malaria burden being lost, thus compromising efforts towards malaria elimination programmes. Furthermore, resistance is also threatening the Global Plan for Insecticide Resistance Management (GPIRM) that seeks to preserve or prolong the effectiveness of vector control interventions [8].

In absence of malaria vaccine (RTS,S/ASO1 under piloting in three African countries including Kenya), one of the barriers of malaria transmission is the use of insecticides that target female Anopheles spp. The currently popular method of malaria control relies on a few insecticide classes and specifically on pyrethroids, which are active ingredients of all WHO-recommended products used in long-lasting insecticide-treated nets (LLINs) and indoor residual spraying (IRS). Pyrethroids are preferred to other chemicals such as organochlorines due to their safety and effectiveness in malaria vector control strategies.

The other barrier which has led to the reported decline in the global malaria burden is the rapid scale up of the use of artemisinin-based combination therapies (ACTs) for treatment of uncomplicated *Plasmodium falciparum* malaria. This malaria management strategy is also being perforated by the emergence of drug-resistant malaria parasite stains particularly in the Southeast Asia [9]. Antimalarials have been reported to be very effective at the beginning but subsequent clearance of parasites leads to great selection pressure of parasite making it more fit to survive and multiply even under the influence of drugs [10]. Even though in Africa, *P. falciparum* remains largely susceptible to ACTs, there is the possibility of spread of the drug-resistant strains to Africa [11]. There is a concern that resistance to artemisinin could also enter into WHO AFR via SEAR as happened previously with chloroquine [4,12]. Moreover, emergence of insecticide and/or drug-resistance is an evolutionary phenomenon. This is why there is need to sustain research in filling the gaps in knowledge on mechanisms of insecticide-resistance and monitoring the impact of current resistance management strategies to address both insecticide and drug resistance. In Kenya, the National Malaria Control and Prevention Programme (NMCPP) in collaboration with other key stakeholders in malaria

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Received: August 25, 2019; **Accepted:** September 06, 2019; **Published:** September 10, 2019

control is spearheading a control strategy which is aiming to reach pre-elimination for most parts of the country. However, considerable heterogeneity in prevalence of the disease within the country and especially the remaining high prevalent region of the Lake endemic region [13] is likely to slow progress towards this target. Like in many malaria endemic countries, the main malaria preventive tool in Kenya is the ITNs and indoor spraying with insecticides [4]. The significant drop of malaria over the last two decades has been attributed to scale-up of insecticide treated bed nets and indoor spraying in highest-risk areas as well as preventive doses of antimalarials. Since the modern malaria control strategy relies on pyrethroids and there is increasing resistance of malaria vectors to pyrethroids and its products, the pre-elimination target is at risk and may not be achieved unless other novel products are developed and rolled out. Recent data [14] have reported that mosquitoes of western Kenya are susceptible to chlorfenapyr (pyrrole) and chlothianidin (neonicotinoid). More effective insecticides with different modes of action on the malaria vectors could be evaluated for inclusion into the insecticide rotation, combination and mixtures malaria control strategies to help in solving the problem of insecticide resistance.

With the on-going challenges related to emergence of artemisinin resistance in Southeast Asia and the threat of resistance in Africa [7] and insecticide resistance mosquitoes, continued surveillance is important for monitoring treatment efficacy and genetic markers associated with anti-malarial drug resistance in Kenya and the rest of malaria-endemic Africa. Moreover, the impact of insecticide resistance on vector control operations require epidemiological monitoring and reporting, which are sometimes inadequate. Active surveillance is expensive but is useful for the provision of up-to-date and easily accessible insecticide and drug resistance data that are interpretable at operationally relevant scales. Although Kenya has made progress in this area, more is still required even in the face of the fragile funding for malaria control programme [4]. Reports have shown that removal of selection pressure can reduce insecticide resistance. For example, in Colombia, the replacement of pyrethroids with fenitrothion (organophosphate) reduced resistance gene in the vector population to below detectable level. This does not sit well with the Kenyan's ambitious campaign of delivering about 15 million insecticide-treated bed-nets to areas considered to need them most [4] for instead of interrupting malaria transmission, it may fuel and stabilize resistance genes in the population.

Conclusion

With the current situation, malaria elimination is a long-term goal in Kenya. What then do we need? We need to invest both human and financial resources in continuous surveillance using routine therapeutic efficacy studies and research for development of newer and more effective malaria prevention and control tools. There is need for strong collaboration between the NMCPP and its key partners and academic institutions, particularly universities. Political and financial support from the county governments (domestic financing) where malaria is endemic must be on top priority if malaria pre-elimination target has to be achieved. This collaboration must also involve the communities where malaria is endemic since active community engagement will improve the uptake of malaria intervention tools. There must be a targeted investment in malaria research and development if Kenya has to remain in the fight against malaria burden and make progress towards malaria elimination target of 2030.

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