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Editorial Open Access

Malaria Vector Surveillance and Insecticide Resistance Monitoring and Management

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Editorial

As global efforts to control and eliminate malaria intensify, vector control interventions are being extensively deployed in the context of the World Health Organization (WHO)-led integrated vector management (IVM) strategy [1]. Indoor residual spraying (IRS) and insecticide treated nets (ITNs), supplemented by focalized larval source management, have been harnessed for interrupting transmission [2]. Unfortunately, the efficacy of both IRS and ITNs risks to be markedly undermined by the selection of insecticide resistance in major malaria vectors [3] and their increasing behavioural shifts towards more exophilic, zoophic and/or exophagic and crepuscular-biting tendencies [4]. It is critical for malaria vector control programmes to establish vector surveillance systems that monitor spatio-temporal changes in vector behaviour and biology in order to guide deployment of vector control tools.

Insecticide resistance has developed in most major malaria vectors to all the four classes of insecticides presently available for public health use i.e. Organophosphates, organochlorines, carbamates and pyrethroids which are the only class used for the impregnation of ITNs [3]. Resistance is emerging and spreading at a faster pace and threatens to potentially compromise the gains already attained in malaria control and thus delay progress towards elimination [5]. Varied levels of resistance to different classes of insecticides, mediated by different mechanisms have been reported in major malaria vectors from Africa, India and South East Asia, and Central and South America [6]. Presently, 64 countries have document presence of resistance to at least on insecticide in major malaria vectors world-wide. In Africa alone, 27 countries have reported pyrethroid resistance malaria vectors [7]. The situation is further aggravated by occurrence of "multiple resistant" populations that could resist to different classes of insecticides, particularly in Africa [6]. There is also nominal data on resistance in secondary vectors which can play an important role in malaria transmission in specific settings. To date entomological and epidemiological impact of resistance is not clearly visible, and resistance has only been directly implicated in operational control failure of pyrethroids in South Africa [8]. The impact of resistance on vectorial capacity of malaria vectors remains grossly under explored with only minimal and conflicting evidence available [9]. Clearly, resistance surveillance and management efforts should be stepped-up in malaria endemic countries to successfully control and eliminate the disease.

Subsequent to attainment of universal coverage with effective LLIN and/or IRS, and successful control of indoor resting and biting malaria vectors, robust outdoor/residual malaria transmission persist due to adaptation of vectors to rest and feed outdoors [10]. Excito-repellent actions of insecticides, including contact irritancy and non-contact repellency, result in loss of vector responsiveness to host cues [11]. In response to insecticides, vectors can develop behavioural plasticity or a consistent "protective behaviour", such as: exophily-natural or induced avoidance of contact with treated surfaces within houses and early exit from them , thus minimizing exposure hazard of vectors which feed indoors upon humans; exophagy-feeding upon humans when they are active and unprotected outdoors, thereby attenuating personal protection and any consequent community-wide suppress ion of transmission; zoophily-feeding upon animals, thus minimizing contact with insecticides targeted at humans or houses; or early-biting-early-evening or early-morning biting; including, behaviouristic resistance-resting outdoors, away from insecticide-treated surfaces of nets, walls and roofs; resulting in a minimal contact with the insecticides used indoors [10].

Notably, innovative strategies are urgently needed to better reduce the vectorial capacity of mosquitoes and hence effectively reduce the burden of malaria. To effectively control and eliminate malaria, mitigation of resistance and controlling residual transmission requires diverse approaches relative to contemporary vector control tools [4]. The new vector control tools should be intended to target outdoor and early feeding mosquitoes. Thus necessitating exploration of new paradigms for controlling and/or interrupting malaria transmission and their adaptation to the local context for enhanced protective efficacy [4]. Efforts should be expended towards the operationalization of the tools that are currently been developed such as the Durable wall linings, Attractive toxic sugar baits, Spatial repellents, Entomopathogenic bacteria traps, Entomopathogenic fungus-impregnated targets, Eave tubes [12] and new molecules for IRS i.e. Chlorfernapyr [13] including improved housing [14], drainage and space spraying [15]. To achieve all this, enhanced entomological surveillance and insecticide resistance monitoring will be crucial in evaluating these tools.

Evidence-based decision making depends on continuous entomological monitoring schemes, including mosquito collection, identification, and analysis, e.g. insecticide susceptibility and residual/outdoor transmission, and then ideally, mapping layered on other environmental and epidemiological information and timely feedback of this systematically collected data [16]. Innovations in mapping technology such as VectorMap: http://www.vectormap.org/ and other GIS/remote sensing initiatives could be harnessed for improved entomological risk assessments and stratification [16]. Entomological surveillance will also provide information on probable vectors and their potential role in malaria transmission, in addition tobeing pivotal in planning, implementing and evaluating the efficacy and effectiveness of malaria vector control interventions. While community-based

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entomological monitoring schemes would be cost-effective vector surveillance approaches [17], entomological capacity can be strengthened by partnering with academic and research institutions that could support training of entomologists and laboratory technicians and facilitate data analysis and interpretation [18].

In response to these challenges, the WHO urged member states to develop IVM-based vector control strategic plans and to elaborate insecticide resistance management (IRM) and malaria vector surveillance plans, including building of requisite capacity for entomological monitoring and vector control [19]. To this effect the WHO developed the Global plan for insecticide resistance management plan (GPIRM) [7] and the Framework for development of national insecticide resistance monitoring and management plans [21]. However, their implementation remains minimal with only a few countries having successfully operationalized the strategies [20,22]. Accordingly, the WHO African Region Office has developed a Draft Operational Manual for the Surveillance of Malaria Vectors [23] and a Framework for the development of national malaria vector surveillance plans [18] for member states to invariably update insecticide resistance and vector bionomics profiles of local vector populations [19]. This will facilitate rational decision making in the deployment of interventions, sustain their effectiveness and optimize the use of the limited available resources for malaria vector control and elimination.

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