Update

Anopheles stephensi: The new challenge in the prevention of re-establishment of malaria in Sri Lanka

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With an estimated 229 million malaria cases being reported in 87 malaria-endemic countries in 2019, malaria continues to be a major public health problem [1]. Following a decline of the malaria cases to near zero in 1963, malaria re-emerged as a public health problem in Sri Lanka in 1967. Despite the persistence of the vector, Sri Lanka interrupted malaria transmission and achieved zero indigenous cases since 2012. The certification of elimination from the World Health Organization was received in 2016. Sri Lanka is currently in the Prevention of Re-establishment (PoR) phase. During this phase, the focus is to maintain the country's malaria-free status by preventing the occurrence of introduced cases (cases contracted locally, linked directly to a known imported case) and indigenous cases secondary to introduced cases. Sri Lanka remains at high risk of re-establishment due to the continued presence of the malaria vector in the country as well as global travel and trade. Since the elimination, except one introduced case and one induced case of malaria reported in 2018 [2] and 2021 [3] respectively, all reported cases of malaria were imported (contracted abroad) [4]. In this background, as global travel and trade are inevitable, entomological surveillance and appropriate vector control measures play a vital role in sustaining malaria-free status.

The primary vector for malaria transmission in Sri Lanka is *Anopheles culicifacies. An. subpictus, An. annularis, An. vagus, An. tessellatus* and *An. varuna* have been identified as secondary vectors responsible for malaria transmission, all being rural species. In December 2016, for the first time in Sri Lanka, an invasive potential vector; *Anopheles stephensi,* was found on the island of Mannar, during a routine entomological survey [5]. In September 2017, it was reported from the Vavuniya district and within one month, it was reported from the other three districts of the Northern Province. *An. stephensi* is a highly competent urban malaria vector, efficient in transmission of both *Plasmodium vivax* and *P. falciparum.* Empirical studies and records show that *An. stephensi* typically breeds in containers or cisterns with clean water [2]. Furthermore, it is found that this vector can quickly adapt itself to the local environment and withstand extremely high temperatures. Thus, it is considered an efficient vector of urban malaria. Until 2011, detection of *An. stephensi* was confined to several countries in South-East Asia and Arabian Peninsula [6]. It is implicated as the main vector of urban malaria in India and is reported to have caused malaria outbreaks [5]. A major issue encountered with *An. stephensi* is that the adult vector cannot be successfully controlled by main control methods used i.e., indoor residual spray (IRS) as they appear to be genetically resistant to a range of insecticides [6].

In Sri Lanka, *An. stephensi* is confined to four districts: Jaffna, Mannar, and Vavuniya districts (Northern Province) and, Kalmunai region (Eastern Province). Available entomological data reveals that *An. stephensi* primarily breeds in used/abandoned wells in Sri Lanka. Other breeding sites reported include overhead tanks, water storage cement tanks (ground level) and water storage containers (eg: barrels, buckets), and ponds [5]. Over the years, with improved transport accessibility and increased inter-district travel, the impending threat of *An. stephensi* introduction to

other areas, especially the Western Province is a matter of great concern. Previously malaria was an entirely rural disease in Sri Lanka and cities were spared of the disease because the vectors of malaria were rural species. Now with over 70% of the imported cases being reported from Western Province [7], the emergence of an urban vector like *An. stephensi* can have potentially dire consequences.

Eliminating or even controlling *An. stephensi* is a daunting task, needing continuous vigilance as well as well-executed control measures. It is vital to ensure the spread of *An. stephensi* is restricted to the current localities which by itself is a laborious task. In addition, continuous monitoring is also essential in other districts, where *An. stephensi* could migrate from the localities of Northern and Eastern Province. District borders with high population flux such as transport hubs are under continuous surveillance for *An. stephensi.* Hence, the Anti Malaria Campaign Head Quarters (AMC HQ) together with regional teams routinely conduct entomological surveys in high-risk areas of all districts to detect potential breeding sites. This activity is further strengthened by collaborating with the National Dengue Control Unit which has included *An. stephensi* identification in routine dengue larval surveys. This is facilitated by the fact that *An. stephensi* could breed in places where dengue vector breeds. This information is disseminated at the regional level. In areas where *An. stephensi* is already present, the AMC HQ and regional teams conduct frequent entomological surveillance and carry out appropriate larval source management such as larviciding and introduction of larvivorous fish. By 2017, through rigorous vector control activities, AMC HQ was able to free several Medical Officers of Health (MOH) areas in Vavuniya (Vavuniya MOH), Kilinochchi (Karachchi and Palei MOHs), and Mullaitivu (Puthukudiirippu MOH) of *An. stephensi.* However, within this period the vector was reported in Jaffna, Kopai, Nallur, and Point Pedro MOH areas where control of *An. stephensi* was proving to be difficult. Following this, the AMC strengthened surveillance and control activities in Jaffna and Mannar, whilst maintaining vigilance in other districts. Yet, in June 2018, Kalmunai region reported *An. stephensi* in Akkaraipattu, Addalachchenai and Alayadivembu MOH areas with re-emergence of the vector in Vavuniya MOH in December 2019. A total of sixteen MOH areas in the four districts in North and East Provinces (including the above) have reported the presence of *An. stephensi* between 2017 to 2019. With the continued actions of the AMC HQ and regional teams, *An. stephensi* distribution has been brought down to ten MOH areas in 2020 and nine MOH areas in 2021 along with successful restriction of inter-district vector transmission. To date, there is no evidence of the expansion of *An. stephensi* to other districts of Sri Lanka. Considering the invasive nature and potential of this vector to transmit malaria in urban areas, strict vigilance and robust control measures are paramount to keep this vector at bay.

Author declaration

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