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Commentary

Disregarding reservoirs of disease vectors: A surveillance paradox in Africa

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Vector borne diseases (VBDs) continue to sustain the huge burden of communicable diseases in Africa, as efficient indigenous and invasive vectors expand their range and abundance. Consequently, malaria, lymphatic filariasis, and arboviral diseases, such as chikungunya, dengue, yellow fever and Zika virus disease, Rift Valley fever and West Nile fever persist [1]. Efficient mosquito vectors, *Aedes aegypti, Aedes albopictus, Culex quinquefasciatus* and the invasive *Anopheles stephensi* thrive in urban areas, are climate sensitive, epidemic prone and problematic given the high urban population in Africa (43.8%) and the inherent annual growth rate (4.1%) [2]. The risk of malaria and arboviral diseases is exemplified by recurrent epidemics, with some declared as public health emergencies of international concern [1,3]. In 2016, a high-level panel on Global Response to Health Crises recommended strengthening emergency preparedness and response for various diseases including VBDs with emphasis on surveillance, and increasing resources for research and development for vaccines, therapeutics and diagnostics [3]. Accordingly, the World Health Organization underscores surveillance in the Global Vector Control Response 2017-2030 (GVCR) to inform evidence-based integrated vector management (IVM) [4].

Integrated entomological surveillance for arboviral diseases, malaria and lymphatic filariasis is key for effective vector control in urban areas [5]. Cemeteries are usually situated in highly populated urbanized localities and serve as a harborage for populations of vector mosquito species due to availability of natural resources [5]. While global surveillance on apposite vectors of arboviruses, urban malaria and lymphatic filariasis has been extensive and encompassing cemeteries, efforts remain outstandingly less exhaustive in Africa.

Ae. aegypti is the primary vector of arboviruses and the invasive *Ae. albopictus* is a secondary vector, both breed in artificial water-filled containers like tyres, cisterns, flowerpots, vases, bromeliads, discarded jars, metal drums and construction sites. Lymphatic filariasis is primarily transmitted by *An.* mosquito species in rural areas and by *Cx. quinquefasciatus* in urban and peri-urban areas. *An. stephensi* breeds in man-made water storage containers such as wells, roof gutters, cisterns, domestic wells and water tanks alongside *Ae. Aegypti* and *Cx. quinquefasciatus,* both vectors of Rift Valley fever and West Nile fever [2]. These vectors also have differences and similarities in their bionomics including biting behavior, whereas *Ae. aegypti* is a day biting species, *An. stephensi* and *Cx. quinquefasciatus* biting times range from crepuscular to nocturnal. *An. stephensi* is an established malaria vector in Asia and the Middle East, and responsible for urban malaria epidemics. The species has invaded countries in the Horn of Africa in Djibouti, Ethiopia, Sudan and Somalia. Consequently, in 2019 a WHO Technical consultation assessed the situation and a vector alert was produced to prompt action [6]. Insecticide resistance has developed in *An. stephensi, Ae. aegypti* and *Cx. quinquefasciatus* and threaten to compromise effective control of the peri-domestic breeding and biting vectors [7]. Given that *Ae. aegypti* and *Cx. quinquefasciatus* have been characterized in cemeteries [8], and data on *An. stephensi, Ae. aegypti* and *Cx. quinquefasciatus* in African cemeteries is non-existent (Table 1), integration with current malaria surveillance and research is essential.

Chikungunya, dengue, and Zika virus disease are devoid of specific treatment with challenging diagnoses, and candidate vaccines exists for chikungunya and Zika virus disease but licensed ones are not currently available. Vector control is the only available intervention albeit with minimal effectiveness in epidemics, necessitating innovation in development of tools that are amenable in epidemic and emergence settings [9], particularly Wolbachia, gene drives, sterile insect technique, vector traps, attractive toxic sugar baits and spatial repellents. While effectiveness of vector control is contingent on entomological and epidemiological evidence, transformation from reactive to proactive and sustainable strategies including integration of neglected areas is critical [9]. Cemeteries are potentially significant foci for proliferation of *Aedes* and *Culex* mosquito vectors [8], as demonstrated by entomological surveillance in Europe, the Americas, and South East Asia and the pacific, except in Africa (Table 1). Although regional and national policies, guidelines and frameworks on integrated management of arbovirus vectors have been formulated and promulgated with legislation enacted, cemeteries are still disproportionately disregarded in Africa. To eliminate VBDs in Africa,

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Table 1
Mosquito vector species breeding in water-filled artificial containers including vases, flowerpots, bromeliads, discarded jars and bottles and natural habitats like bamboo stumps and tree-holes within cemeteries and the notable gap of data for Africa.

Mosquito vector species	Geographic location/ Region				References
	Americas	Europe	South East Asia/ Pacific	Africa	
Aedes (Stegomyia) aegypti	+	+	+	–	(2,8)
Aedes (Stegomyia) albopictus	+	+	+	–	(2,8)
Ochlerotatus japonicas/Ochlerotatus triseriatus	+	+	+	–	(8,10)
Culex quinquefasciatus	+	–	+	–	(2,8)
Culex pipiens complex	+	–	+	–	(8)
Culiseta incidens/ Cs. inornata	+	–	–	–	(8)

reinvigorated surveillance including integration of cemeteries as part of IVM will be indispensable.

Harnessing salient bionomic and environmental attributes common to vectors for lymphatic filariasis, arboviruses and urban malaria would be critical to exploit the potential of IVM. Increasing urbanization provide ideal conditions for vectors and increases potential of community awareness and engagement [2]. Salient characteristics of breeding in water-filled flowerpots, vases, bromeliads, discarded jars, bottles and rainwater collection make *Ae. aegypti, An. stephensi* and *Cx. quinquefasciatus* presence in African urban cemeteries a plausible research postulate, and their sympatric-existence in water storage containers in peri-domestic environments could optimize vector control [2,8]. Insecticide susceptibility monitoring and evaluation in disease vectors facilitates resistance management to sustain interventions [7]. *Aedes*-transmitted Zoonoses potentiates improvement of multisectoral active surveillance within the One Health Approach.

With increasing urbanization, built up environments have encroached on sprawling cemeteries in Africa. While the framework for implementation of the GVCR in Africa includes vector surveillance, research and innovation, there is a notable dearth of information on vector proliferation in cemeteries (Table 1). This disregard may result partly from the perception of cemeteries that connote enormous cultural and spiritual sensitivity [10]. Considering the threat of arboviral diseases and urban malaria epidemics, proactive entomological surveillance in cemeteries is eco-epidemiologically significant and vital for health security. Methodologies would encompass early detection and monitoring of mosquito vector species, ecological approaches to establish habitat preferences, and mosquito control studies to evaluate vector control tools [8]. There is need to promote research in cemeteries to generate requisite evidence and to hearten strong collaboration among the health sector, local authorities and pertinent partners with vested interests. Other partners include the environment sector, academic and research institutions, policy makers, funders, vector control implementers and communities.

Declaration of Competing Interest

EC declares no competing interests.

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