Horizon Scanning

TechScan

Report No. : 005/2021

VECTRACK

(An Earth Observation Service for Preventive Control of Insect Disease Vectors)

Keyword : vectrack, entomological surveillance, optoelectronic sensor

SUMMARY OF TECHNOLOGY

VECTRACK is an entomological surveillance system which combine a novel intelligent mosquito sampling with remote sensing and modelling technique.The objective of VECTRACK is to obtain integrated and real-time quality information on mosquitoes disease vectors to improve surveillance and control strategies and reduce the risk of their transmission.[1]

VECTRACK comprised of optoelectronic sensors attached on top of an existing adult mosquito active trap (BG-Mosquitaire) which allow fully remote, automated counting and classification of target mosquitos (sex, species,age and infection potential) at the field, evaluate density, build risk maps and predictive models of the species of mosquito vectors of diseases. When VECTRACK is placed at georefenced point, the BG Mosquitaire containing artificial human scent called BG-Sweetscent from BiogentsAG will emit an odor to attract mosquitos to the trap. When mosquito flies close to the mouth of funnel, it will be sucked through the tunnel into catchbag by overpower air flow created by electrical fan. Traditionally, the mosquitos will be collected and examined by entomologically trained personel in laboratory to identify its' species, gender and age. However, by using the novel optoelectronic sensor in VECTRACK, the mosquitoes will be sensed before being trapped in the catch bag.[2] Identification of species, sex and age of the mosquito will be based on frequency of flight and the shape of their body. The optoelectronic sensor was trained to identify, classify and characterize *Aedes Aegypti, Aedes Albopictus and Culex pipiens.*[2] The sensor also collect the GPS position of traps, and information on temperature and humidity.[1]

All data collected by sensor will be sent to a cloud system to be analyzed by algorithms. It is then processed in geographic information systems that are provided by Avia-GIS company through VECMAP tool. The VECTRACK sensors are able to be installed throughout most of the globe. They are compatible with many different communication protocols such as 2G, 3G, 4G, Wi-Fi, LPWAN technologies NB-IoT and LoRA, and satellite IoT. The European Space Agency (ESA) provides satellite information which the data is integrated into. The real-time risk maps that are developed by the

researchers through the process can be provided to regional, national, and international public-health bodies e.g. Center for Disease Control to allow planning of disease control and prevention.

VECTRACK was developed by Irideon, a Spanish-German company based in Spain which specialised in sensor-based products. VECTRACK have not received any approval at the moment. The Institute of Agrifood Research and Technology (IRTA) in Catalonia, Spain have adopted VECTRACK project to be tested on field which funded was by European Commission under Horizon 2020.[3] First pilot field test was held in 2020 in the city of Barcelona by the Public Health Agency of Barcelona (ASPB) and expected to finish in 2022. VECTRACK will be commercialised as a service to the market segments already serviced by the industry partners, and new international clients.

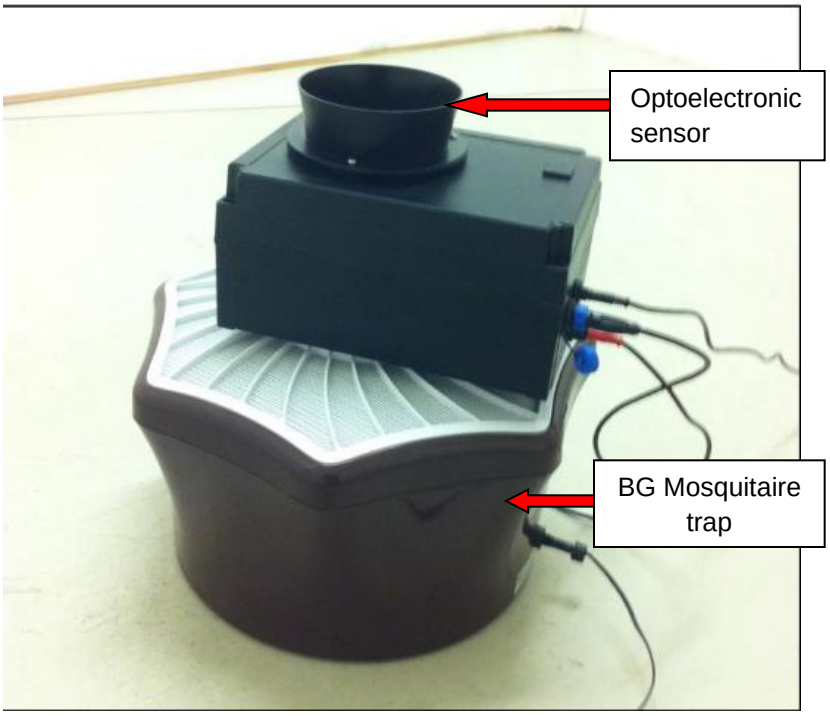

Figure 1. VECTRACK – optoelectronic sensor on BG Mosquitaire trap.

INNOVATIVENESS

Novel, completely new	/
Incremental improvement of the existing technology	
New indication of an existing technology	

DISEASE BURDEN

Mosquito-borne diseases are among the most important global public health problems and are associated with significant economic burden in affected countries. Mosquito-borne diseases are those spread by the bite of an infected mosquito e.g. Zika, West Nile disease, Chikungunya, dengue, and malaria.[4] Dengue virus is transmitted by female mosquitoes mainly of the species *Aedes aegypti* and, to a lesser extent, *Aedes albopictus. Culex. pipiens* appears to be a major vector of both West Nile, Rift Valley,Japan encephalitis fever Usutu Viruses, canine dirofilarial worms, and avian malaria parasites.

Dengue is a mosquito-borne viral disease that has rapidly spread in all regions of WHO in recent years. Dengue virus is transmitted by female mosquitoes mainly of the species *Aedes aegypti* and, to a lesser extent, *Aedes albopictus*. These mosquitoes are also vectors of chikungunya, yellow fever and Zika viruses. The global incidence of dengue has grown dramatically in recent decades. There are an estimated of 100-400 million infections each year.The number of dengue cases reported to WHO increased over 8 fold over the last two decades, from 505,430 cases in 2000, to over 2.4 million in 2010, and 4.2 million in 2019. Reported deaths between the year 2000 and 2015 increased from 960 to 4032. Asia representing about 70% of the global burden of the disease.[5]

In Malaysia, number of dengue cases and incidence rate (IR) continue to increase with the highest number ever reported was in 2019. In that year, a total of 130,101 dengue cases were reported which was equivalent to IR of 390.4 cases per 100,000 population. During the period 2000 - 2019, the annual number and the incidence rate of dengue cases in Malaysia varied substantially, from the lowest value of 7,103 cases (30/100,000 population) in 2000, reaching a peak of 120,836 cases (390/100,000 population) in 2015. After the peak, there was downward trend in 2016, 2017, 2018 with yearly reduction of 16.1%, 17.3% and 3.9% of cases respectively. However, in 2019, there was an increase of 61.4% dengue cases[6]. The incidence of dengue infection is generally expected to increase to nearly four times higher in year 2020 compared to baseline year 2010 and almost six times higher in year 2040 compared to baseline year 2010.[7]

CURRENT OPTIONS

Integrated vector management (IVM) is defined as a rational decision-making process for the optimal use of resources for vector control, aiming to improve efficacy, cost-effectiveness, ecological soundness and sustainability of disease-vector control with ultimate goal to prevent vector-borne diseases transmission including dengue. Entomological surveillance is one of the important parts in IVM element which support evidence-based decision making with epidemiological surveillance and evaluation.[8]

Entomological surveillance is used to determine changes in the geographical distribution and density of the vector, evaluate control programmes, obtain relative measurements of the vector population over time and facilitate appropriate and timely decisions regarding interventions. Mosquito surveillance consists of routine monitoring of both larval and adult mosquito populations over the course of an entire mosquito season[9].

Generally, there are two types of traps used in entomological surveillance for adult mosquitos i.e Pasive and active traps. Passive traps are low cost and capture gravid *Ae. Aegypti* using funnels, sticky cards, or insecticides and without electricity. In these traps, water or an infusion of hay is used to attract the insects. The catch rates of passive traps depend on factors such as size, color, and type of attractant, among others. In the other hands, active traps use an electrical device to capture adult mosquitoes e.g. BG-Sentinel - a battery- operated fan that sucks the insects into the trap.[10]

The mosquitos trapped will be collected and transported to entomology laboratory for counting and identification of species, sex, age and infection potential. Entomological of surveillance needs expert entomologists and may be time consuming due to its laborious method

POTENTIAL IMPACT OF TECHNOLOGY

Search was conducted through electronic databases such as MEDLINE, PubMed, manufacturer's and regulatory bodies websites up to 10 March 2021 using these keywords either singly or in combination; VECTRACK, entomological surveillance, optoelectronic sensor.

One diagnostic study and one cost effectiveness study were found relevant and included in this review.

a. Clinical Impact

The optoelectronic sensor of VECTRACK was tested against Aedes Aegypti, Aedes Albopictus and Culex pipiens. From the study, the sensor is useful for genus classification with accuracy ranged from 93.83% to 95.73%. In gender identification, the accuracy based on species ranged from 93.11% to 99.05%. The accuracy in terms of age ranged from 69.81% to 90.97%.[2] Table 1 elaborate the accuracy results for the different mosquitos species.

However, there were some limitation reported in the study. Since the identification of species using the optoelectronic sensor and artificial intelligence is made on wingbeat patterns of a mosquito, same genus may share similar wingbeat patterns (*Ae. albopictus* and *Ae. Aegypti*) suggesting that the classification between two groups in the same genus would be challenging. More data and training will be necessary to optimize the sensor and increase its accuracy.

Species classification		
Species		Highest accuracy
Aedes albopictus and *Culex pipiens*		93.83%
Aedes. aegypti and *Culex. pipiens*		95.73%
Aedes aegypti and *Aedes albopictus*		76.06%
Sex		
Culex pipiens		93.11%
Aedes albopictus		94.27%
Aedes. aegypti		99.05%
Age based on sex		
Culex pipiens	Female	78.04%
	Male	69.81%
Aedes albopictus	Female	90.97%
	Male	86.84%
Aedes. Aegypti	Female	71.42%
	Male	70.75%

Table1. Accuracy of optoelectronic sensor of VECTRACK in classification of mosquitos.

b. Cost

There was no retrievable evidence on cost of VECTRACK. However, similar program of entomological surveillance using geographic information system (GIS) and passive mosquito trap (sticky trap) may be beneficial for reference.

One cost effectiveness study reported that implementation of Intelligent Dengue Monitoring System (MID) in 21 cities in Brazil is cost effective in dengue prevention. MID is a vector surveillance program implemented by trapping female Ae. aegypti citywide at fine spatial and temporal scales to detect high Aedes

infestation areas using a GIS environment. The program also include identification of arbovirus- infected trapped mosquitoes by RT-PCR. Real-time adult mosquito surveillance data and entomological indices were produced by this program and help in planning of disease control and prevention. The total cost of the program for all 21 cities for 2 years of work was less than US$ 1.5 million, making an average of US$ 71,428 per city. The number of people benefited by the program was approximately 2 million, making the cost per habitant per year around US$ 0.70. The cost-effectiveness was calculated as the cost of running the program divided by the number of cases of prevented arboviral diseases compared with cities that did not use the MID program and relied only in the national dengue guidelines. The MID program prevented a total of 27,191 cases at a total cost of US$ 7.5 million, thus saving approximately US$ 0.4 million in direct costs (health care and vector control) and US$ 7.1 million in lost wages (societal impact) annually.[10,11]

c. Organisational - services , infrastructure, human resources
   There was no retrievable evidence on organizational issues of VECTRACK. However, a few issues need to be taken into account in implementing this technology. The electrical supply may need to be considered in planning of BG Mosquitare and optoelectronic sensor placement on the field since BG-Mosquitaire trap require power supply 12V to operate. Other than that, communication protocol of area which VECTRACK is planned to be placed need to be verified as the system is compatible with 2G, 3G, 4G, Wi-Fi, LPWAN technologies NB-IoT and LoRA, and satellite IoT.

d. Societal/ethical
   There was no retrievable evidence on social/ethical issues of VECTRACK.

e. Safety
   There was no retrievable evidence on safety issues of VECTRACK.

CONCLUSION

VECTRACK is a novel technology which combined fully remote, automated counting, classification of target mosquitos and remote sensing to develop real-time risk maps. The optoelectronic sensor of VECTRACK was tested against Aedes Aegypti, Aedes Albopictus and Culex pipiens and showed acceptable accuracy in distinguishing its genus, sex and age. VECTRACK may have potential in improving surveillance and help in planning of vector borne disease control strategies and reduce the incidence of vector

borne diseases such as dengue fever. However, further studies are needed to determine its accuracy to ensure its applicability and implementation in field setting.

EVIDENCE

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Disclosure: The author of this report has no competing interest in this subject and the preparation of this report is totally funded by the Ministry of Health, Malaysia.

Disclaimer: TechScan report is prepared based on information available at the time of research and a limited literature. It is not a definitive statement on the safety, effectiveness or cost effectiveness of the health technology covered. Additionally, other relevant scientific findings may have been reported since completion of this report.

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