INTEGRATED VECTOR MANAGEMENT: PANACEA FOR MALARIA CONTROL

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Authors' contributions

This work is a collaborative effort among the authors. Author CCO is the lead, initiator and corresponding author of this Review article. He addressed the aspects of Introduction and Literature search. Author JKA is our Medical Director and a Consultant Surgeon of long standing who contributed to the Discussion and Recommendations of the article. RNN is an astute professor of Microbiology who wrote the Abstract and contributed in the literature search.

ABSTRACT

Integrated vector management (IVM) is a selective application of numerous control measures and management techniques either simultaneously or sequentially for effective control of vectors. It is a technique for managing vector populations in the bid to mitigate or interrupt transmission of diseases. IVM is based on the presupposition that proper control is not the exclusive responsibility of the health industry but needs the joint efforts of many other agencies, community interest and involvement. Existing literature on the Review article were retrieved through Google Scholar, PubMed, Journals, Personal communication and e-library searches, and the literature reviewed. Taking Anopheles mosquito as an example, the bionomics of an anopheles mosquito starts from:

Egg → Larva → Pupa → Adult
The main objective of IVM is to avert the transmission of vector-borne diseases like malaria. An effective mosquito control measure should encompass: environmental, chemical, biological and genetic control measures.
The IVM through its Global Strategic Framework should be developed to tackle various insufficiencies and frailties in vector control and to enhance the efficacy, cost-effectiveness, ecological soundness and sustainability. There must be emphasis on the promotion of interdisciplinary integration and inter-sectoral cooperation between relevant stakeholders at all levels.

Keywords: Integrated, Vector, Management, Malaria, Control

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1. INTRODUCTION

Integrated vector management (IVM) is a selective application of various control measures and management techniques either simultaneously or sequentially for effective control of vectors. It is a technique for managing vector populations in the bid to mitigate or interrupt transmission of diseases [1]. IVM features are basically on awareness of elements affecting local vector biology, disease communication and morbidity, use of various dimensions and scope of interventions, often in joint effort and synergistic, alliance and teamwork within the health industry and with other relevant sectors relating to the study, involvement with indigenous communities and other stakeholders and a public health regulatory and legislative framework. An IVM-based procedure should be economical and posses signs for measuring and monitoring potency. It should be able to sustain approaches compatible with local health that allow adequate planning and decision-making to take place at the lowest possible administrative levels [2].

IVM is based on the presupposition that effective control is not the exclusive preserve of the health sector but needs the collaboration of various public and private agencies, community participation and involvement. The commitment of communities is an important driver in assuring sustainability. IVM calls for the use of various dimensions and scope of interventions of tested and attested efficacy, separately or in combination, in order to achieve more economical control and mitigate reliance on any single intervention [3].

2. METHODOLOGY

Existing literature on the Review article were retrieved through Google Scholar, PubMed, Journals, Personal communication and e- library searches, and the literature reviewed. This review also used MEDLINE and cited references to identify relevant studies.

3. DISCUSSION

Arthropods are made up of the most numerous and varied of the living things in the environment of man. Some of them are man's friend and colloborator helping in the fertilization of flowers, but a good number of arthropods are not beneficial man and thereby constitute man's most dreaded and dangerous enemies. They destroy his crops and his food reserves and some act as vectors or carriers of diseases like tularemia, Japanese encephalitis, Saint Louis encephalitis, Western equine encephalitis [4]. Mosquito is the vector of the disease known as malaria. Malaria and other mosquito-borne diseases result in nearly 700 million illnesses each year and over one million deaths [5]. Mosquito-borne diseases (MBDs) include malaria, dengue, west Nile virus, chikungunya, yellow fever, filariasis, leshmaniasis, eastern equine encephalitis, Venezuelan equine encephalitis, Ross River fever, Zika virus, la crosse encephalitis, sindbis virus, Rift valley fever, Jamestown Canyon Virus and Snowshoe Hare Virus [6]. They remain a substantial problem in the tropics. They are culpable for a significant chunk of the global disease burden and have serious and wighty effects not only on health but also on the socio-economic development. MBDs contribute a significant bottleneck and setback to socioeconomic development in resource-poor countries. Malaria which is transmitted by the anopheles mosquito remains one of the top five killers in the developing world. It is also responsible for more than 500 million episodes of the disease each year which has a huge knock on economic-[7, 8].

Over the years, morbidity and mortality from malaria is a growing Public health challenge. Malaria has been expanding due to weakening health systems in many nations, increased mosquito defiance to insecticides, parasite defiance to anti-malaria drugs and sluggish progress in vaccine development. Taking Anopheles mosquito as an example, the bionomics of an anopheles mosquito starts from:

Egg → Larva → Pupa → Adult

Fig. 1: Schematic representation of anopheles mosquito bionomics

An IVM strategy will try to arrest transmission at every stage of the development making sure that the population of the vector is reduced including killing of the adult mosquitoes and if the mosquitoes evade all these measures then one employs personal protective measures [9]. A good IVM intervention should be efficient, cost-effective, ecologically sound, economically, politically acceptable and environmentally friendly [10].

The main objective of IVM is to avert communication of vector-borne diseases like malaria. An effective mosquito control measure should encompass: environmental, chemical, biological and genetic control measures [11]. The basic and typical chemical, biological and physical management measures used to terminate mosquitoes and other insects vectors, as well as active and passive case-detection and treatment of human infection, have a long and proven track-record of saving lives. While interventions using only insecticide treated nets (ITN) and/or indoor residual spraying (IRS) coverage mitigates transmission severity and the burden of malaria in many situations, it is not obvious if these interventions alone will achieve those critical low levels that result in malaria extermination [11].

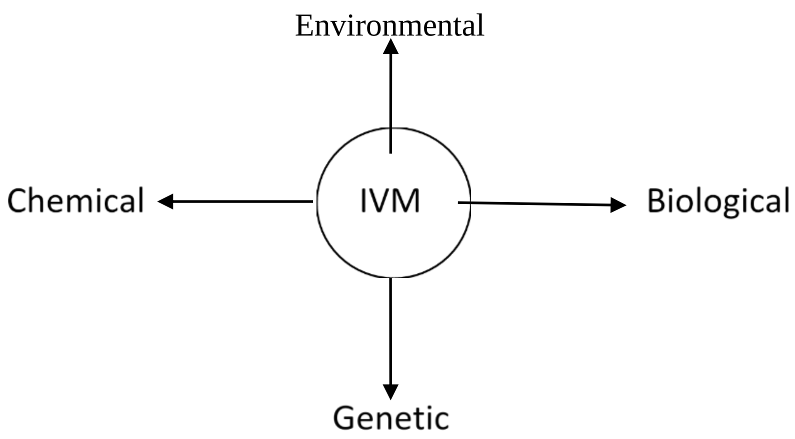

Fig. 2: Diagram showing various control measures.

The environmental measures aim to monitor and manipulate environmental factors in view of reducing vector population and minimizing man-vector pathogen contact [12]. Various environmental measures include environmental modification, environmental manipulation of human habitats. The technique of environmental modification involves effective drainage system, elimination of small vector collections, topographic alteration of the irrigation fields and water velocity alteration. Others include water modification (water level fluctuation), control of vegetation. More so, modification of human habitats could be achieved through the use of mosquito screen plastering and filling of holes and cracks.

Biological measures employ natural enemies of the vector and biological toxins These may include the use of voracious eaters of mosquito larva called Larvivorous fish, Gambusia fish, invertebrate predators, nematodes, protozoa, fungi and some bacteria like Bacillus thuringiensis and spore forming bacteria which produce lethal toxins [13].

Chemical measures will involve the use of wide range of insecticides for vector control. Commonly used ones are dichlorodiphenyltrichloroethane, malathion, sodium fluoride, methyl bromide, permethrin and cypermethrin.

Genetic control measures include the Sterile Insect Technique (SIT) which is a species-specific and environmentally friendly method for insect population reduction. It is based on mass breeding, radiation mediated sterilization, and release of a large number of male insects. Releasing of insects carrying a dominant lethal gene (RIDL) offers a solution to many of the drawbacks of traditional SIT that have limited its application in mosquitoes while maintaining its environmentally friendly and species-specific utility. Other mechanisms include chromosomal translocations, sex distortion, gene replacement method and hybrid infertility [14]. Newer IVM methods include the use of pheromones to repel male mosquitoes Insecticide impregnated mosquito nets that are treated with deltamethrin and cyfluthrin that are effective for 6 months [15].
The fight against malaria requires not only funding, relevant and adequate technology and political will/commitment, but also a blueprint and action plan, operational lines and procedure of responsibility and adaptive/suiting management systems, able to learn from and correct mistakes. IVM seeks to apply these principles to the control of vectors of disease [16].

5. RECOMMENDATIONS

Effective Vector-borne control strategy is endowed with enormous benefits for health and socioeconomic development. The fight against malaria requires not only funding, relevant and adequate technology and political will/commitment, but also a blueprint and action plan, operational lines and procedure of responsibility and adaptive/suiting management systems.
IVM should be able to support works that further improves methods and techniques needed for reduced transmission or better eliminating the disease. It should be able to find out and encourage processes and activities that create long-term partnership between Control programmes and International Experts and Institutions to solidify operational research components of IVM programmes [17].

The IVM through its Global Strategic Framework should be developed to tackle various insufficiencies and frailties in vector control and to enhance the potency, economical tendency, ecological correctness and sustainability. IVM is based on the presupposition that adequate control is not the exclusive responsibility of the health industry but needs the joint efforts of relevant agencies (public and private), community interest and involvement. Implementation of this action plan will need efficient public health regulation, legislation and policy combined with a strong effort and concerted action by the United Nations.

There must be strong emphasis on the adequate promotion of interdisciplinary integration and inter-sectoral relationship and cooperation between relevant stakeholders at all levels. It should be able to provide necessary orientation to Policy makers within WHO and member states on the development and implementation of IVM [18]. To achieve these goals and create strong and effective advocacy for IVM, WHO should strengthen the existing linkages and coordination. A strategic action plan for the implementation of IVM should be developed. If we use all the weapons available, there is hope of eliminating malaria, this is IVM. A multifaceted attack on malaria is required. We need to implement a concerted effort in using the entire weapon available to us; drugs, bed nets, insecticides, transgenic, vaccine.

COMPETING INTERESTS

Authors have declared that no competing interests exist, either in form of consultancy, honorarium or grant.

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