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Analysis of a vector-bias effect in the spread of malaria between two different incidence areas

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Abstract

In 2005, Lacroix et al. demonstrated that infected humans are more attractive to mosquitoes, a phenomenon known as the vector-bias effect. The aim of this study was to determine how a vector-bias effect affects the changes in the dynamics of malaria transmission, and the changes in control strategies and cost-effectiveness for optimal control considering the regional characteristics or force of infections for different transmission rates. We used a vector-bias mathematical model and considered two different incidence areas: a high transmission area and a low transmission area. Our results showed that the dynamics in the two areas differed; as bias exists and the strategy for optimal control could be changed in the different areas. Thus, this work may give that considering the vector-bias effect in different areas facilitates prediction of the future dynamics and make decisions for establishing controls. We also mention the evolution of malaria parasites in this study.

Keywords: malaria transmission dynamics, a vector-bias effect, endemic-size, low transmission, high transmission, sensitivity analysis, optimal control, cost-effectiveness analysis

1. Introduction

Some mosquitoes exhibit host selectivity (Kingsolver, 1987). Particularly, some mosquitoes tend to bite humans and these mosquitoes are known as *Anthropophilic* mosquitoes. Anthropophilic mosquitoes play an important role in many mosquito-borne disease dynamics.

Malaria transmission dynamics is one of the most important mosquito-borne disease dynamics caused by a large genus of *parasitic protozoa, Plasmodium* (Anderson et al., 1992). People are infected from 4 species of malaria parasites; *P.vivax, P.malariae, P.ovale* and *P.falciparum*. Especially, *P.falciparum* malaria is so fatal to people that it might cause death of infected people. The disease is transmitted most commonly by an infected female *Anopheles* mosquito (WHO, 2015). If infected mosquito bites human, malaria parasites, which are in the salivary gland of mosquito, go into the blood of human. With the help of blood stream, these parasites reach the liver which is called exposed period. Once the exposed period is over, parasites exit the liver and invade into the red blood cells and consequently symptoms like a fever, vomiting, chilling, and headache occur (Beare et al., 2006). In red blood cell, malaria parasites develops into gametocytes and ensure the transmission of malaria to another host. If malaria vector contacts at that time, then they can become infected mosquito (Cowman et al., 2012).

Mosquitoes adapt to their surroundings, resulting in a rapid increase in their population. Because of the rapid spread of mosquito-related infectious, it is very important to develop methods and vaccines to decrease and eradicate these infections. However, the role of mosquito behavior in malaria transmission dynamics remains ambiguous. Therefore, additional studies are needed.

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