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Hypothesis: Impregnated school uniforms reduce the incidence of dengue infections in school children

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ABSTRACT

Dengue infection causes a significant economic, social and medical burden in affected populations in over 100 countries in the tropics and sub-tropics. Current dengue control efforts have generally focused on vector control but have not shown major impact. School-aged children are especially vulnerable to infection, due to sustained human–vector–human transmission in the close proximity environments of schools. Infection in children has a higher rate of complications, including dengue hemorrhagic fever and shock syndromes, than infections in adults. There is an urgent need for integrated and complementary population-based strategies to protect vulnerable children. We hypothesize that insecticide-treated school uniforms will reduce the incidence of dengue in school-aged children. The hypothesis would need to be tested in a community based randomized trial. If proven to be true, insecticide-treated school uniforms would be a cost-effective and scalable community based strategy to reduce the burden of dengue in children.

Introduction

Dengue viruses are the most widespread geographically of the arboviruses and are found in tropical and subtropical areas where 2.5 billion to 3 billion people are at risk of infection [1]. Not only are dengue outbreaks increasing in numbers, but the disease is also extending to new geographical areas [2]. Dengue inflicts a significant health, economic, and social burden on the populations of endemic areas. Globally, the number of disability-adjusted life years (DALYs) per million population lost to dengue is estimated to be between 528 and 621 per million population [3]. Each year an estimated 50–100 million dengue infections occur, with several hundred thousand cases of dengue hemorrhagic fever (DHF) and some 20,000 deaths.

Dengue in children

Children carry the main burden of morbidity and mortality [4]. Dengue is often more severe in children and associated with a higher risk for dengue hemorrhagic fever [5]. Infection in children causes large disruptions in schooling, and parental wage earning, which in turn has large direct impacts on nutrition and overall family health [6]. For example, in Northern Thailand, it has been estimated that dengue contributes 465.3 DALYs per million population per year among school-aged children in Northern Thailand, which accounts for 15% of all DALY loss from febrile illness in this age group [7]. One investigator stated that, "In Thailand, over the past 40 years, 65% of reported cases were confined to the 5–14 years age group. The reason for this is likely to be an increase in mosquito breeding and an epidemic of dengue in schools." [8] Reducing the incidence of dengue in school children will not only reduce morbidity and mortality but also reduce the number of school days lost, increase school performance and reduce the economic burden on parents.

Vector control

Dengue viruses are transmitted by mosquitoes of the genus *Aedes*, subgenus *Stegomyia* (e.g., *Aedes aegypti* and *A. albopictus*). *A. aegypti* is well established in much of the tropical and subtropical world and is the main epidemic vector [1]. As a peridomiciliary mosquito, *A. aegypti* is well adapted to urban life and typically breeds in clean, stagnant water (e.g., rain water) and thrives in proximity to humans. In the absence of an effective drug or vaccine, the main strategic intervention to reduce dengue transmission is vector control. Integrated vector management can reduce vector densities considerably, but its effect on dengue activity remains poor [9]. Routine interventions against the immature

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stages of the vector have proved ineffective [10]. Novel community based approaches have been investigated such as using insecticide-treated covers for water storage jars [11], larvivorous fish [12] and predacious copepods as biological control agents in water containers [13]. However, questions remain as to their scalability, sustainability, and cost-effective delivery, alone or in combination.

Insecticide treated fabrics have emerged as a key component of arboviral disease control efforts, in particular for the control of malaria. Insecticide treated bednets have been shown to be a successful intervention for the control of malaria [14]. Although insecticide-treated bed-nets are the most cost effective community based intervention to reduce malaria due to the dawn/dusk and night biting activities of malaria-carrying mosquitoes, their use has no or little impact on dengue incidence due to the differing mosquito feeding patterns. Window curtains and domestic water container covers treated with insecticide can reduce densities of dengue vectors to low levels and potentially affect dengue transmission [15]. Additional novel approaches using insecticide treated materials need to be evaluated for the control of dengue. Personal clothing would potentially be an excellent target as clothes are worn during day times. There have been a variety of programs that have applied insecticide technology to personal clothing, but this has been limited to military and recreational markets, and not community based protection. There is an urgent need for integrated and complementary population-based strategies to protect vulnerable children.

The hypothesis

We hypothesize that insecticide-treated school uniforms will reduce the incidence of dengue infections in school-aged children.

Rationale for our hypothesis: as children spend a considerable amount of their day at school, it is likely that schools are primary sites for exposure to the day-time biting Aedes mosquitoes. Several authors have suggested schools to be one of the main sites of infection [16–19] and schools should therefore be a key target for control. From a pragmatic point of view, schools would be an easier target rather than dispersed populations. School uniforms are a cultural norm in most developing countries, worn throughout the day on an almost daily basis.

The question arises why have impregnated school uniforms not been used to date? Traditionally it has always been thought that dengue is mainly acquired in and around homes [20,21]. Furthermore, until recently the main age groups affected by dengue were small children before school commencement [21]. However, there is a shift in age towards older children observed in many dengue endemic countries [16].

Evaluation of the hypothesis

As no studies exist on impregnated school uniforms, our hypothesis needs to be tested with a large scale community based double-blind randomized controlled trial. The study should be conducted in highly endemic areas during the high transmission season. Outcome parameters should not only be the incidence of laboratory confirmed dengue infections in school-aged children but also entomological indices at school premises.

Consequences of the hypothesis and discussion

If our hypothesis proves to be true that impregnated school uniforms reduce dengue infections in children, this would be a simple, safe and cost-effective intervention, that is sustainable through community-based programs. Such a strategy will not only have potential savings from money saved (out of pocket and health system) for treatment of illness, but it also has the potential of improving human development in children by reducing loss of school days and enhancing school performance. This approach has the advantages of being very cost-effective, making widespread implementation feasible in countries with limited resources, and making this intervention easily "scaled-up for impact."

References

[1] Gubler DJ. The global emergence/resurgence of arboviral diseases as public health problems. Arch Med Res 2002;33(4):330–42.
[2] Wilder-Smith A, Gubler DJ. Geographic expansion of dengue: the impact of international travel. Med Clin North Am 2008;92(6):1377–90.
[3] Dengue: guidelines for diagnosis, treatment, prevention and control, ed. W.H. Organization. 2009, Geneva: World Health Organization.
[4] Guzman MG, Kouri G. Dengue: an update. Lancet Infect Dis 2002;2(1):33–42.
[5] Hammond SN et al. Differences in dengue severity in infants, children, and adults in a 3-year hospital-based study in Nicaragua. Am J Trop Med Hyg 2005;73(6):1063–70.
[6] Clark DV et al. Economic impact of dengue fever/dengue hemorrhagic fever in Thailand at the family and population levels. Am J Trop Med Hyg 2005; 72(6):786–91.
[7] Anderson KB et al. Burden of symptomatic dengue infection in children at primary school in Thailand: a prospective study. Lancet 2007;369(9571): 1452–9.
[8] Kantachuvessiri A. Dengue hemorrhagic fever in Thai society. Southeast Asian J Trop Med Public Health 2002;33(1):56–62.
[9] Ooi EE, Goh KT, Gubler DJ. Dengue prevention and 35 years of vector control in Singapore. Emerg Infect Dis 2006;12(6):887–93.
[10] Nathan MB. Critical review of Aedes aegypti control programs in the Caribbean and selected neighboring countries. J Am Mosq Control Assoc 1993;9(1):1–7.
[11] Seng CM et al. The effect of long-lasting insecticidal water container covers on field populations of *Aedes aegypti* (L.) mosquitoes in Cambodia. J Vector Ecol 2008;33(2):333–41.
[12] Seng CM et al. Community-based use of the larvivorous fish Poecilia reticulata to control the dengue vector Aedes aegypti in domestic water storage containers in rural Cambodia. J Vector Ecol 2008;33(1):139–44.
[13] Kay B, Vu SN. New strategy against Aedes aegypti in Vietnam. Lancet 2005;365(9459):613–7.
[14] Muller O et al. Effects of insecticide-treated bednets during early infancy in an African area of intense malaria transmission: a randomized controlled trial. Bull World Health Organ 2006;84(2):120–6.
[15] Kroeger A et al. Effective control of dengue vectors with curtains and water container covers treated with insecticide in Mexico and Venezuela: cluster randomised trials. BMJ 2006;332(7552):1247–52.
[16] Ooi EE et al. Dengue seroepidemiology in Singapore. Lancet 2001;357(9257):685–6.
[17] Endy TP et al. Spatial and temporal circulation of dengue virus serotypes: a prospective study of primary school children in Kamphaeng Phet, Thailand. Am J Epidemiol 2002;156(1):52–9.
[18] Sharma, R.S., N. Panigrahi, and S.M. Kaul, Aedes aegypti Prevalence in Hospitals and Schools, the Priority Sites for DHF Transmission in Delhi, India. Dengue Bulletin, 2002; 25: 107–108.
[19] Jarman RG et al. Microevolution of Dengue viruses circulating among primary school children in Kamphaeng Phet, Thailand. J Virol 2008;82(11):5494–500.
[20] Mammen MP et al. Spatial and temporal clustering of dengue virus transmission in Thai villages. PLoS Med 2008;5(11):e205.
[21] Gubler DJ. Epidemic dengue/dengue hemorrhagic fever as a public health, social and economic problem in the 21st century. Trends Microbiol 2002;10(2):100–3.