The Development and Testing of Water Storage Jar Covers in Cambodia

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Abstract

This paper describes how community-based, participatory action research in Cambodia led to the development of an innovative mosquito-proof cover for the most important larval habitat of *Aedes aegypti*, concrete jars commonly used to store water in Cambodian households. Made from long-lasting insecticide-treated materials, the jar cover is now undergoing field trials organized by the national Dengue Fever Control Programme in Kampong Speu Province, Cambodia.

Keywords: *Aedes aegypti*, dengue, water storage jars, covers.

Country setting and background

Cambodia is situated in South-East Asia and shares borders with Thailand, Viet Nam and the Lao People's Democratic Republic. It is considered a homogeneous society with 90% of the 12.5 million people being of Khmer origin and sharing the same religion, Buddhism. Cambodia is predominately an agrarian society with 85% of the population living in rural areas. The tropical climatic comprises two seasons: the rainy season from May to October and the dry season from November to April.

The first case of dengue haemorrhagic fever (DHF) was reported in 1962 and the country has since experienced frequent DHF outbreaks[1]. These mostly affect children in areas with concentrated populations, particularly Phnom Penh and Battambang. Epidemics throughout the 1980s and 1990s resulted in high DHF case fatality rates, ranging from 3.6% to 15%. Dengue has become a major public health problem in the country.

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The Government began intensive control efforts as a result of the 1995 epidemic. The National Dengue Fever Control Programme (NDCP) was established and had two goals: (i) to improve early detection of and response to outbreaks; and (ii) to educate communities to participate in the reduction of mosquito vector breeding. The programme combined vector control (application of the larvicide temephos to water-filled containers to control immature stages, and insecticide space spraying to kill flying adult mosquitoes) with case management, public education (mass-media campaigns), and strengthening of epidemiological surveillance.

In 1998 there was an unprecedented epidemic of DHF, mainly affecting the capital, Phnom Penh and neighbouring Kandal Province[2]. The NDCP mobilized resources, with assistance from the International Federation of Red Cross and Red Crescent Societies (IFRC), and carried out extensive vector control measures including the distribution of 56 tonnes of temephos 1% SG to 560,000 households over a period of three months. A new Geographical Information System (GIS) for dengue proved helpful in identifying the priority areas for control interventions. Despite the large-scale response, transmission spread to 12 provinces that were previously unaffected, including those in rural areas. It became clear, especially after the 1998 epidemic, that a long-term strategy for vector control was needed, as well as an effective emergency response. This paper describes how participatory action research led to the development of an innovative mosquito-proof cover for the most common and productive larval habitat of *Aedes aegypti* in Cambodia, the concrete household water storage jar.

Planning innovation for dengue prevention and control

Utilizing lessons learned from the 1998 epidemic, the NDCP began to focus on more sustainable environmental management methods of vector control. One method under consideration was a water jar cover or lid that would allow harvesting of rainwater but would not permit entry of egg-laying female *Ae. aegypti*, or other mosquitoes, including the secondary vector of dengue, *Ae. albopictus*.

In an initial Participatory Rural Appraisal (PRA) conducted in Kandal (November 1999) and Kirivong Provinces (February 2000), villagers were asked about their use of and preferences for jar lids or covers. The research showed that people use various types of covers to keep debris and dust out of their jars and to exclude light in order to prevent the growth of algae. The need for covers to be mosquito-proof was not rated highly, although in villages with dengue-related fatalities, residents were very interested in keeping mosquitoes out of their water jars. The communities in Kandal were found to be economically better off than those in Kirivong. This was reflected in the quality of the covers; in Kandal, concrete slabs were commonly used to cover the jars, whereas in Kirivong, lids were less common, and more often made of ill-fitting material, such as wood. Concrete lids, however, were preferred because they were perceived to be cheap, long-lasting and effective in keeping out debris and light. Nevertheless, several respondents mentioned that concrete lids were cumbersome and difficult for children to use. Metal lids were more likely to be stolen or

used by children as playthings. The reason most often given for not covering jars was simply forgetfulness.

Drawing on an understanding of local water storage practices, a Jar Lid Development and Testing Programme was established, involving leaders from the National Malaria Centre, NDCP and a consultant from the World Health Organization. The programme used an action research approach to design jar covers and lids and to test their performance and use in Kandal Province. The aim was to develop a robust jar cover that prevents the entry of mosquitoes, but is also convenient to use so that family members will replace it after use.

Implementing the new project

Initial design work resulted in 19 jar lid prototypes made from different materials, e.g., wood and concrete. The prototypes included lids allowing various means of access to jars and lids that allowed water to drain through mesh or cloth screens. The designs were based on a combination of ideas generated by discussions with local villagers, analysis of the literature and discussions with experts, many of whom had worked on this problem in other cultural settings. To identify the lid design most suitable for local production, an assessment scale was created with various parameters such as cost, 'mosquito-proofness', 'theft-proofness', durability and the ability and willingness of artisans in the village to manufacture the lids. Also, the size of the lid was considered important for cloth and mesh covers, with a larger circumference providing better cover of the jar opening; however, villagers preferred smaller and more compact models because of their convenience.

Based on the assessment, one jar cover in particular stood out from the other designs as appearing to be the most suitable. It comprised of a simple rattan hoop, with a slightly larger circumference than the rim of the jar, and supporting a fine mesh net. A stone attached to a string was hung from the centre, anchoring the lid so that it would not blow off in strong winds. Attaching the stone also proved to be useful when taking water from the jar, as the lid could be moved aside and the stone prevented it from falling off, thus making it easier to reposition.

Of the 19 different designs tested by programme staff, a smaller number were then selected for use in community-based trials in Ksaach Kandal:

- Polypropylene hoop with netting, held down by a centrally suspended weight;
- Hoop as above but with aluminium netting;
- Wooden rack with cloth beneath;
- Hinged wooden rack with cloth beneath;
- Iron sheeting with a segment or section that hinged open;
- Concrete with a smaller section for lifting and replacing.

Monitoring and evaluating the project

For these jar cover and lid designs, pre-testing represented the next step so that the number of potentially suitable lids could be

further reduced, and then used in a formal trial. The results of the PRA surveys indicated that full acceptability may not occur until the people are familiar with a particular design so that its advantages and disadvantages can be fully appreciated. During the trial period NDCP staff carried out monthly cross-sectional mosquito larvae surveys to confirm the efficiencies of the various lids. Lids that rated highly in terms of acceptability, including 'affordability' and efficiency, were then rated with respect to the feasibility and prospects for developing a social marketing strategy. The outcome of this community-based trial in Ksaach Kandal was the final selection of the polypropylene hoop with netting. Subsequent design work and risk assessment studies resulted in the use of long-lasting deltamethrin-treated polyester netting (PermaNet®) so that the jar lid would not only physically prevent adult mosquitoes from entering the jars, but would also kill newly emerging adults and kill or deter gravid females attempting to oviposit in them. Initial field trials in three villages of Kampong Speu resulted in a substantial reduction in the densities of immature stages over the 12-week study period. The impact on adult mosquito populations was less evident. Full details of the field trials will be published elsewhere. There was widespread enthusiasm for and acceptance by the communities of the jar cover intervention (Figure) A larger scale field trial using covers incorporating further modifications (including a drawstring design and incorporation of an ultraviolet protectant to extend the duration of effectiveness of the insecticide) are under consideration.

Figure. ***Jar cover design with PermaNet ® netting used in the field trials***

Lessons learned

This initiative shows that even apparently simple interventions require extensive dialogue with community groups and multidisciplinary research. Locally appropriate solutions such as jar covers can be designed or adapted to keep mosquitoes from water containers but substantial improvements can be made during the design and trial phases if participatory research is used to actively engage intended end-users. Participatory field trials yield important information on the attitudes of villagers and their requirements for jar covers. They may also contribute to the development of new solutions.

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