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ORIGINAL ARTICLE

Field evaluation on the effectiveness of a modified approach of chemical fogging against the conventional fogging in controlling dengue outbreak

M OMAR, S ZALIZA, M MARIAPPAN, AO ZAINAL and KB CHUA*

*Jabatan Kesihatan Negeri Sembilan, Negeri Sembilan, Malaysia and *Makmal Kesihatan Awam Kebangsaan (National Public Health Laboratory), Kementerian Kesihatan, Malaysia.*

Abstract

A field evaluation on the effectiveness of a modified approach of chemical fogging of insecticides against the conventional method was carried out in the Seremban district within the state of Negeri Sembilan, Malaysia from 7th February 2003 to 7th September 2003. In the 3 months period, November 2002 to January 2003, prior to institution of modified approach of chemical fogging, 27 of 42 (64.3%) dengue outbreaks were successfully controlled within the stipulated time frame of 14 days by the conventional approach of thermal chemical fogging. However, during the period when the modified approach of chemical fogging was instituted, 25 of 27 (92.6%) dengue outbreaks within the same district were successfully controlled within the14-days time-line. Statistically, the modified approach of chemical fogging significantly improved the success rate of achieving dengue outbreak control within the stipulated time frame ($\chi 2 = 5.65$, $p = 0.01745$). The modified approach of chemical fogging also appeared to reduce the number of dengue cases recorded in the same district.

This small pilot study shows that the modified approach of chemical fogging reduced cost in carrying out each fogging activity to control dengue outbreak. It also substantially reduced the required time taken to complete each fogging activity in comparison to the conventional approach. Thus, it enabled similar number of workers to cover more localities simultaneously affected by the outbreaks. In addition, the modified approach reduced the exposure time to hazardous insecticides for each worker doing hand-held thermal fogging.

Key words: Dengue outbreak, insecticide fogging, thermal, ultra-low volume.

INTRODUCTION

During a dengue outbreak, fogging of insecticides e.g. Malathion, Reslin and other synthetic pyrethroids is usually carried out to try to achieve rapid knockdown and killing of adult mosquitoes in the affected area.[1,2] In this context, fogs are clouds of fine droplets (aerosols) of insecticide varying in size between 5 and 50 micron that remain suspended in the air for a period to allow the aerosolized insecticides to penetrate deeply into every part of the affected area. The droplet nuclei which are less than 5 microns in diameter have suitable drift characteristics, but do not readily impinge on adult mosquitoes. However, if the droplet nuclei are larger than 2.5 microns in diameter, they will have suitable impingement characteristics but do not drift sufficiently.[3-5]

In thermal fogging, the insecticides in suitable formulation are vapourised at a high temperature to produce a fog. Thermal fogs can be oil-based or water-based. Oil-based solutions produce dense clouds of white smoke whereas water-based solutions produce colourless mist. Both are equally effective. The droplet (or particle) size produced by thermal fogging is usually of less than 2.5 microns in diameter, depending on the flow rate used to generate the fog.[3-5]

Ultra Low Volume (ULV) fogging is a method of application of a minimum volume of liquid insecticide formulation (usually less than 500 ml/hectare) per unit area. It provides maximum efficiency in killing target adult mosquitoes. For ULV, the optimum droplet size usually falls within 10-15 microns in diameter. The ULV

Address for correspondence and reprint requests: Dr Kaw Bing CHUA, Makmal Kesihatan Awam Kebangsaan, (National Public Health Laboratory), Ministry of Health, Lot1853 Kg. Melayu, 47000 Sungai Buloh, Selangor, Malaysia. Tel: 603 6126 1200; Fax: 603 6140 2249 ; email: chuakawbing@yahoo.com.sg

aerosol droplets are usually larger than thermal fog droplets but are of a more uniform size. As in thermal fogging, the flow rate affects the size of the droplets generated. Normally, there are 56 billion droplet nuclei being generated from a single fluid ounce (30 ml.) of insecticide.[6-12] The advantage of ULV fogging is such that there is no need for costly diluents and can be mounted on a moving vehicle. Thus, a smaller volume of insecticide is needed to be transported to the field which in turn, leads to elimination of storage and mixing problems.

Both ULV and thermal fogging should not be carried out in heavy rain.[6-12] They are permissible in light showers and as a good practical guide to go by, especially for ULV fogging, if visibility can be maintained with the windshield wipers of the mounting vehicle in intermittent mode but have to be discontinued if the windshield wipers need to be switched to continuous mode. This field study compares the effectiveness of a modified chemical fogging against the conventional fogging of insecticide in controlling dengue outbreak.

MATERIALS AND METHODS

The study was carried out in the Seremban district within the state of Negeri Sembilan, Malaysia. The study period started in 7th February 2003 and ended in 7th September 2003 for the modified chemical fogging approach and a combined approach followed soon and extended until 31st January 2004. In the combined approach, the selection of localities were random and by convenient sampling method. The application of the modified approach was independent and alternating with that of the conventional approach of chemical fogging in the control of dengue outbreak occurring in each locality.

In the conventional strategy of chemical fogging to control dengue outbreak, thermal fogging was conducted within 24 hours upon receiving notification of a clinical case of acute dengue. The thermal chemical fogging was carried out in the affected area covering an area of 200 meters radius from the house of the reported case. Upon laboratory confirmation of the case, a second chemical fogging was instituted in the same affected area within 7 to 10 days after the initial fogging. Resigen at 1:50 dilution was the type and final concentration of insecticides used. All pre-mixing was done in a clean container and the final formulation was filtered before filling the holding tank of the fogging machine.

In the modified approach of chemical fogging, a similar strategy was taken as above except the thermal chemical fogging using similar insecticides was carried out in the affected area covering an area of 50 meters radius from the house of the reported case and the remaining extended perimeter of 150 meters was covered by ultra-low volume fogging. The type and final concentration of insecticides used was the same as in thermal fogging except diesel was used as diluent and the process of fogging was carried out by machine mounted on the floor of a truck of a 4 wheel-drive vehicle. The detailed process and methodology of the standard ULV fogging used in this study were in accordance with the national vector-borne guidelines.[1]

The ability to control the dengue outbreak within 14 days that occurred in each locality within the Seremban district was used as the outcome indicator. The date of the first recorded case of confirmed acute dengue to the date of the last recorded case of confirmed acute dengue in the affected locality was taken as the outbreak period. Other parameters, such as, number of man-hours needed for the fogging operation, quantity of insecticides used, and cost on the usage of vehicles were monitored and recorded.

Previous outcomes of control on dengue outbreaks in localities within the same district using the conventional approach of chemical fogging were used as the baseline indicator for comparison with the modified approach of chemical fogging.

RESULTS

In the 3 months period (November 2002 to January 2003) prior to institution of modified approach of chemical fogging, there were 42 dengue outbreaks in various localities within the district of Seremban. Twenty seven of the 42 (64.3%) outbreaks were successfully controlled within the time frame of 14 days using the conventional approach of thermal chemical fogging. However, during the period when the modified approach of chemical fogging was instituted, there were 27 dengue outbreaks within the same district and 25 (92.6%) were successfully controlled within the14-days time-line. Statistically, the modified approach of chemical fogging significantly improved the success rate of dengue outbreak control within the stipulated time frame ($\chi 2 = 5.65$, $p = 0.01745$).

TABLE 1a: Result of dengue outbreak control in 10 localities using modified approach of fogging during the extended period

No.	Name of locality	Date of 1st Case	Date of Last Case	Control Period
1	Taman Panchur Jaya	16.8.03	28.8.03	12 days
2	Taman Desa Mantin	29.8.03	7.9.03	7 days
3	Taman Seremban Jaya Phase 3	19.9.03	3.10.03	14 days
4	Green Street Home	29.9.03	8.10.03	10 days
5	Quarters Police, Mambau	2.10.03	7.10.03	2 days
6	Taman Rasah Jaya Phase 3	6.10.03	8.10.03	2 days
7	Paroi New Village	23.10.03	26.10.03	3 days
8	Taman Tuanku Jaafar Phase 2	2.11.03	4.11.03	2 days
9	Jalan Tok Ungku	11.11.03	17.11.03	7 days
10	Taman Desa Melor	1.12.03	8.12.03	7 days

In the period from mid-September to end of December 2003 when both approaches were independently instituted, 20 localities were noted to have dengue outbreaks (Table 1a and 1b). All the 10 localities with dengue outbreaks were successfully controlled within 14 days when the modified approach of chemical fogging was carried out (Table 1a). However, 3 of the 10 localities with dengue outbreaks failed to be controlled within the stipulated time-line at the occasion when the conventional chemical fogging was adopted as the control measure (Table 1b).

On an average, RM736.32 (RM408.00 for workers' overtime salary, RM112 for petrol and diesel for vehicle's fuel and diluent of insecticides, RM216.32 for cost of insecticides) was needed to carry out one conventional approach of chemical fogging. The cost for carrying out one modified approach of chemical fogging was RM474.99 (RM125.00 for workers' overtime salary, RM57.75 for petrol and diesel for vehicle's fuel and diluent of insecticides, RM292.24 for cost of insecticides). Six hours was normally needed to complete the conventional chemical fogging in one locality whereas the amount of time required to complete the modified approach of chemical fogging in one locality was 2 hours and 30 minutes.

DISCUSSION

The practice of conventional chemical fogging to control dengue outbreak in Malaysia was introduced in 1986 and has not been changed since then. The principle and reason for adopting this small pilot study in instituting the modified approach of chemical fogging to control dengue outbreak is based on a couple of field observations of changing behaviour of dengue virus vectors and epidemiological features of patients who came down with acute dengue during previous dengue outbreaks in Seremban district. Epidemiological analysis

TABLE 1b: Result of dengue outbreak control in 10 localities using the conventional approach of insecticide fogging during the extended period

No.	Name of residence	Date of 1st Case	Date of Last Case	Control Period
1	Taman Tuanku Ampuan Najiah	29.9.03	24.10.03	**26 days**
2	Kombok Estate	6.10.03	22.10.03	**16 days**
3	Flats Kem Senawang	9.11.03	16.11.03	7 days
4	Taman Desa Melor	1.12.03	8.12.03	7 Days
5	Taman Senawang Jaya	8.12.03	25.12.03	**17 days**
6	Taman Sri Permata	23.11.03	7.12.03	14 days
7	Jalan Rasah	27.10.03	1.11.03	4 days
8	Taman Pinggiran Senawang	16.12.03	27.12.03	11 days
9	Taman Tasik Jaya	22.12.03	24.12.03	2 days
10	Taman Panchor Jaya	25.12.03	27.12.03	2 days

of previous outbreaks showed that the disease mainly affected patients of ages between 15 and 45 years old who spent most of their time outdoor (Unpublished data). Aedes mosquito survey carried out during similar period showed that positive vector breeding sites were found mainly outside the houses. Thus, the applied basic reason then is to focus intensive hand-held thermal fogging of 50 meters radius around the house of the case to knock-out any infective adult *Aedes* mosquitoes and cover the remaining 150 meters by ULV using vehicle-mounted machine to reduce time and man-power that were normally involved in the conventional approach. The time saved can be subsequently used to improve coverage of other affected areas to be fogged. This would in turn increase the capacity of the local dengue team to cover more localities affected by dengue outbreak.

This small pilot study shows that the modified approach of chemical fogging to control dengue outbreak was as effective as, if not more than, the conventional approach. The modified approach resulted in substantial reduction of cost to carry out each fogging activity during the dengue outbreak. However, the main advantage of this modified approach is that it reduced the required time to less than half as normally taken to complete each fogging activity by the conventional approach. Thus, similar number of workers was able to cover more localities simultaneously affected by the outbreaks. This is especially crucial in situation where dengue outbreaks occur in a number of localities within the same district when the man-power is limited.

In the modified approach of chemical fogging, the exposure time for each worker doing hand-held thermal fogging is substantially reduced as he has to cover an area of 50 meters radius around the house of the affected case instead of an area of 200 meters radius as in the case of conventional chemical fogging. Thus, this will reduce the exposure time of the foggers to hazardous insecticides.

This relative small pilot field study was limited by failure to take into account other potential co-founding factors that may affect the outcome of each approach such as variation in rainfall, environmental temperature and relative humidity, community attitudes and motivation of local councilors, seasonal fluctuation and changing pattern of dengue virus serotypes that may occur during the study period. However, an on-going study is undertaken in the same district to compare the modified approach of chemical fogging against the conventional approach in reducing the density of mosquitoes in the area using entomological enumeration of *Aedes* mosquito immature form (larvae and pupae) collected in specific ovitraps.

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