

Status of Indoor Residual Spraying by Deltamethrin in Malaria Elimination Program, Southeastern Iran

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Received: 21.02.2012

Accepted: 11.03.2012

ABSTRACT

Background: Iran is one of the countries implementing indoor residual spraying (IRS) for malaria control. Deltamethrin (DLT) is one of the insecticides recommended by World Health Organization (WHO) for this program. IRS is currently performed in Sistan and Baluchistan province as an area with unstable malaria situation and the highest prevalence of malaria in the country. DLT has been used since 2003 in this area. The purpose of this study is to determine IRS status of DLT in malaria elimination program in this province.

Methods: In this cross-sectional study, data on workers, insecticide formulation, amount of used insecticide, the number of sprayed places, and spray coverage percent in a period of four years between 2008 and 2011 from six districts of the province were collected and analyzed.

Results: IRS was implemented by two DLT formulations (WP 5%, WG 25%) two rounds yearly. Mean of coverage percentage was 85.12 ± 2.47 on fixed places and 95.87 ± 2.47 for temporary places. On average, every worker sprayed in each round eight hours a day (non-continuously) by 6 to 8 pumps containing DLT at 625 to 780 mg^{-lit} concentration. Thus, workers were in contact with high daily doses of DLT mist.

Conclusion: Health system must provide suitable equipment and logistics support for spraymen's health. Also, training workers would certainly be effective. Instructing and explaining the important role of IRS in malaria prevention to households can be effective in spraying coverage augmentation.

Key words: Deltamethrin, Iran, IRS, Malaria.

IJT 2012; 600-604

INTRODUCTION

Iran is one of the countries that use different methods such as indoor residual spraying (IRS) for malaria control and Deltamethrin (WG, WP) is one of the insecticides recommended by World Health Organization (WHO) has played an important role in controlling of malaria vectors (1,2).

Deltamethrin (DLT) with other name (s)- α -cyano-3-phenoxybenzyl (1R, 3R) -3 -

(2,2-dibromovinyl) -2,2-dimethylcyclopropane carboxylate belong to the Pyrethroid insecticides and use widely in the world in agriculture, home pests control, protection from store pests and disease vectors. Deltamethrin classified as half dangerous substances in International Program Chemical Safety (IPCS) and belong to the second type of Pyrethroid (3).

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Indoor residual spraying (IRS) is one of the classical interventions in malaria control that can be applied for inside walls or shelters in areas with endophilic mosquitoes. Recent studies reconfirm that IRS substantially decreases transmission and improves infant and child mortality. IRS decreases malaria transmission by reducing the vectorial capacity (V.C) of the female anopheline. Its impact on V.C is related to several factors, especially high-coverage performance (4). The goal of IRS is to obtain coverage of $\geq 80\%$ in targeted households (1). Also, in Iranian Malaria Elimination Program is expected to increase the protection rate of the population at risk of malaria by IRS in at least 80% of the targeted households (5). It can be used in unstable, epidemic-prone, stable-endemic, and stable-hyperendemic malaria areas (4).

Sistan and Baluchistan province, as unstable malaria situation, is located in southeastern part of Iran and near the border of Pakistan and Afghanistan (Figure 1) and it has the highest malaria prevalence. It contains about 42–60% of the total malaria cases in the country (11). Iran implements IRS as a national intervention program against malaria especially in southeastern foci and DLT has been used since 2003 in this area (6, 10). The purpose of this study is to determine IRS status by DLT in malaria elimination program in a period of four

years between 2008 and 2011 in Sistan and Baluchistan province.

MATERIALS AND METHODS

In this cross-sectional study, we collected and analyzed data about workers, insecticides formulation, amount of used insecticide, the number of sprayed places, and spray coverage percentage during spraying operations from six districts of Sistan and Baluchistan province, including Iranshahr, Saravan, Sarbaz, Nikshahr, Chabahar and Konarak. The IRS operation was carried out by Hudson X-pert® sprayer (8 liters capacity) with HSS-8002 nozzle and with pressure at range 25–45 psi. In this province, IRS had been applied by two types of DLT formulation (WP 5%, WG 25%) two rounds yearly. Statistical analysis was done using SPSS software.

RESULTS

Indoor residual spraying was done in the province for two rounds. The first round was implemented in March and the second round was implemented in July and August. Table 1 shows a summary of IRS information per round yearly. In the present study, spraying coverage percentage of fixed and temporary places were at least 80%. Means of coverage percentages were 85.12 ± 2.47 in fixed places and 95.87 ± 2.47 in temporary places. Paired t-test showed significant differences between spraying coverage of fixed and temporary places in this study ($P = 0.00$).



Figure 1. Location of Sistan and Baluchistan province , I.R.Iran

Table 1. IRS information in malaria elimination program

Sistan & Baluchistan Province, 2008-2011

| Year | Round | No of Sprayed Villages | No of Sprayed fixed places | spraying coverage Percent of fixed places | No of Sprayed temporary places | spraying coverage Percent of temporary places |
|------|-------|------------------------|----------------------------|---|--------------------------------|---|
| 2008 | 1 | 539 | 48877 | 87 | 23626 | 91 |
| | 2 | 480 | 26906 | 84 | 19151 | 96 |
| 2009 | 1 | 556 | 42080 | 86 | 21748 | 98 |
| | 2 | 380 | 28910 | 83 | 16740 | 97 |
| 2010 | 1 | 761 | 59515 | 83 | 62134 | 99 |
| | 2 | 926 | 71761 | 83 | 31808 | 96 |
| 2011 | 1 | 923 | 75291 | 90 | 35473 | 96 |
| | 2 | 723 | 51680 | 85 | 29131 | 94 |

Table 2 shows data on IRS per round yearly. Based on correlational analysis, there are significant correlations between pure consumption insecticide (DLT) and sprayed fixed places ($P= 0.023$, $r= 0.779$) as well as between pure consumption insecticide (DLT) and sprayed temporary places ($P= 0.005$, $r=0.867$).

Based on our studies, every worker sprayed in each round on average eight hours a day (non-continuously) by 6 to 8 pumps containing DLT at 625 to 780 mg^{-Lit} concentration. Thus, workers were in contact with high daily doses of DLT mist.

Another important point is an average of 33.38% of spraymen attended two successive rounds.

In inspection of the spraying teams, using incomplete safety equipment by some workers, especially in the warm months of the year, was observed (Figure 2). They expressed discomfort as skin irritation, especially in the face, neck, and hands, and, in most cases, headache, in the early days. This issue needs to be investigated in other studies.

Table 2. Number of operational teams, workers and their daily function Sistan and Baluchistan province, 2008-2010

| Year | Round | Deltamethrin Formulation | Consumption Deltamethrin (kg) | No of Spraying team | No of Spraymen | Average of daily working | Average of discharged pumps per round | Average of discharged pumps per day |
|------|-------|--------------------------|-------------------------------|---------------------|----------------|--------------------------|---------------------------------------|-------------------------------------|
| 2008 | 1 | WP 5% | 2800 | 43 | 215 | 15 | 104 | 7 |
| | 2 | WP 5% | 1594 | 40 | 200 | 11 | 63 | 6 |
| 2009 | 1 | WP 5% | 3954 | 50 | 250 | 14 | 126 | 9 |
| | 2 | WP 5% | 1506 | 50 | 250 | 11 | 60 | 6 |
| 2010 | 1 | WG 25% | 1540 | 55 | 275 | 16 | 220 | 13 |
| | 2 | WG 25% | 1290 | 55 | 275 | 14 | 180 | 13 |
| 2011 | 1 | WG 25% | 987 | 57 | 285 | 13 | 138 | 10 |
| | 2 | WG 25% | 641 | 46 | 230 | 13 | 111 | 8 |

DISCUSSION

In Sistan and Baluchistan province, IRS was applied two rounds yearly. In a similar study, Raghavendras *et al.* concluded that IRS should be used two rounds at an interval of 3 months for malaria vector control (7). Also, the residual duration of pyrethroids, such as DLT, recommended by WHO is between two and six months approximately (6).

In the present study, more than 83% of the places were sprayed. This is according to the World Health Organization goal (coverage \geq 80% of the targeted households) and Iranian Malaria Elimination Program (at least 80% of targeted households) (1,5). Yukich *et al.* demonstrated that for effective IRS high coverage is necessary and IRS can protect all persons through reduced biting, decreased sporozoite rates, and lower parasitemia rates within the sprayed community (8).

In the present study, there was a significant difference between spraying coverage of fixed and temporary places which shows the greater acceptances of residual spraying in temporary places than fixed places by the households.

As specified in Table 2, discharged pumps and the mean of daily work hours of spraymen has increased in recent years which is indicative of workers' greater contact with DLT at the first and second rounds. Based on our results, workers were in contact with high daily doses of DLT mist. The LC50 of DLT through respiration for 4 hours of contact is 2.2 mg / l and contact more than one hour is 4.6 mg / l for the host rat (9). Acceptable daily intake (ADI) of (DLT) for human has been established between 0 and 0.01. This insecticide can cause transient itchy skin or irritation feeling after contact with human skin. In non-fatal cases, symptoms, such as numbness, itching, paresthesia, skin irritation, and dizziness, were frequently reported (3). Therefore, the use of safety

equipment is very important in prevention of toxicity of workers.

Also, in the present study, using incomplete safety equipment by some workers, especially in the warm months of the year was observed. Zhang *et al.* in China showed that skin is the most important route of pyrethroid absorption and toxicity through the air path is less than 1% in skin route, so decreased skin contact plays an important role in the prevention of insecticides absorption (10).

Moreover, at least 33.38% of the workers were present in two consecutive rounds of spraying; perhaps this group of workers was exposed to higher risks than others. Azmi *et al.* in Pakistan showed that exposure to pesticides for long periods affected the spraymen's health and produced the toxic effects of pesticides, such as dermatological, hepatic, nephritic, and respiratory and other clinical disorders. They suggested that indiscriminate use of pesticides must be regularly assessed and farm workers must be trained before spraying (11).

CONCLUSION

According to national malaria elimination program, IRS must be performed at high quality and coverage to be effective. Achieving this goal requires trained spraymen and increased supervision by skilled health staffs. Although DLT is classified among half-dangerous substances, health system must provide suitable equipment and logistic support for spraymen's health. Training workers and sensitization would surely be effective. In addition, instructing and explaining the important role of IRS in malaria prevention to households can be effective in spraying coverage augmentation.

ACKNOWLEDGEMENTS

The authors would like to thank the staff at Zahedan University of Medical Sciences for their assistance with performing this study.

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