An Effectiveness of Insecticide Spray in the Control of *Visceral leishmaniasis* in Nepal

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Abstract

Introduction	Despite a programme of annual residual insecticide application, Siraha district in southeastern Nepal has been severely affected by *Visceral leishmaniasis*. A study was conducted to assess the effectiveness of the insecticide to control *Visceral leishmaniasis* during the ten years from 1991 to 2001.
Objective	The study aimed to assess and evaluate the effectiveness of the insecticides sprayed for ten years (1991-2001) period in Siraha district and to provide recommendations based on the findings.
Method	Altogether 21 Village Development Committees (VDCs) were selected, based on disease endemicity. Data from the Siraha District Public Health Office were reviewed. Case numbers were compared in the years before and after intervention.
Result	The trend of disease burden was found to be unchanged before or after insecticide spray.
Conclusion	Reviewed data on insecticide spray and reported *Visceral leishmaniasis* cases suggests no successful result to control the disease in Siraha District. Possible reasons for the failure of intervention are discussed.
Key Words	Effectiveness, Insecticides, Kala-azar, Siraha

Introduction

Following the start of the epidemic of *Visceral leishmaniasis* in Bihar State of India in the late 1970s, adjoining districts of Eastern Nepal also became affected by this disease (Joshi, 1996). Since then the disease has spread gradually from the eastern to the western districts of the lowland *Terai* belt. So far, seventeen districts have been reported positive for *Visceral leishmaniasis* (Ministry of Health, 2001 Unpublished Data).

Phlebotomine sandflies used to be considered highly susceptible to all insecticides; but indiscriminate use poses a problem of resistance (Mukhopadhyay *et al.* 1987). *P. argentipes*, the vector of *Visceral leishmaniasis* was found susceptible to DDT (Mukhopadhyay *et al.* 1994, Kaul *et al.* 1994, Chnadra *et al.* 1995), Dieldrin and Malathion (Chandra *et al.* 1995) and tolerance to Lambdacyhalothrin (Amalraj *et al.* 1999).

Resistance to DDT in *P. argentipes*, a proven vector of *Visceral leishmaniasis* in India was reported for the first time in a village of Samastipur district (Mukhopadhyay *et al.* 1990), similarly this vector was also reported to be resistant to Deltamethrin as well (Amalraj *et al.* 1999). Recently, effectiveness of the insecticide (DDT) was found to be 100% in Patna and Samstipur district. In Paswantola and Chakkatola Village (Darbhanga district) and Dakshinitola Village (Vaishali district), vector mortality was 98.24%, 96.28% and 97.57% respectively, where as in another village in Vaishali (Ravidastola) susceptibility was 78.5% in 1998 and 71.42% in 1999 (Singh *et al.*, 2001). Similarly, *P. papatasi* was found resistant to DDT (Mukhopadhyay *et al.* 1994), tolerance to Deltamythrin and resistant to Lambdacyhalothrin (Amalraj *et al.* 1999). Susceptibility tests for *P. papatasi* were carried out during 1985-88 where many houses had been treated with DDT for malaria control (1950-68). The research showed that *P. papatasi* from Isfahan is more tolerant to DDT than flies from other areas (Rashti *et al.* 1992).

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In Nepal, Ministry of Health started a programme of Indoor Residual Insecticide Spraying (IRS) in 1992 for *Visceral leishmaniasis* control with the insecticide labda-cyhalothrin (ICON). As per national IRS policy only those villages were sprayed, where VL cases were recorded in previous years. During 1993,1994 and 1995 DDT, Malathion and Lambda cyhalothrin were sprayed extending over the *Visceral leishmaniasis* affected areas covering approximately 1 to 1.9 million population. This was done annually in eight districts of central and eastern regions. In 1998 approximately 0.6 million population in 9 districts were protected by lambda-cyhalothrin (ICON) indoors residual spraying (MOH-1999).

Despite the spray of different insecticides, every year large numbers of *Visceral leishmaniasis* cases have been reported in the District. Over ten year's period, the country experienced more than 12000 *Visceral leishmaniasis* cases. In Siraha district alone the number of cases were about 2800. Whereas, in the same period, the number of cases in the study VDCs were 752. This indicates that the regular spraying of residual insecticides has not controlled the vector and disease. Retrospective data need to be analyzed for further assessment of the effectiveness of spraying program and insecticides and its relation with disease trend during the ten years.

Methods

Data Source

Siraha District Public Health Office provided data on the use of insecticides in the different years between 1992-2001. Annual *Visceral leishmaniasis* cases reported from the district hospital and actively detected during the *Visceral leishmaniasis* research period were reviewed and assessed.

Study VDCs

Twenty VDCs and one municipality of Siraha District (one of the disease endemic district in Nepal) were selected for the study. The selection of the VDCs was based on the review of *Visceral leishmaniasis* case reports available in Siraha district hospital. VDCs were selected with the 20% sampling strategy.

Siraha district has regularly been studied by TDR grantee in the past. In addition, His Majesty's Government, Ministry of Health with its free treatment and vector control strategy and Vector Borne Disease Research and Training Center with its control and research strategy, has also been intervening the district with different disease control programs for last one decade. Despite all these efforts, the realm of insecticide spraying has been found very poor in its effectiveness. It has been seen that there was no reduction in *Visceral leishmaniasis* cases even after the intervention. Each year, number of cases reported to have been treated from the Siraha District Hospital. Therefore, 20% of 107 VDCs and one municipality were taken for the study and information regarding insecticide spray and disease burdens in respective VDCs were critically analysed. The study VDCs and a municipality, based on the disease endemicity status were presented in table 1.

Table -1: Studied VDCs according to disease endemicity

Category	VDCs and Municipality	Total VDCs
I: Epidemic	Chandrauadaypur, Gadha, Hakpara, Sitapur pra.ra	4
II: Endemic	Badaharamal, Devipur, Kisanpur, Lalpur, Sanhaitha	5
III: Epidemic potential	Asanpur, Aurahi, Bariyarpatti, Bastipur, Inarwa, Itatar, Khirauna, Lahan (Municipality), Madar, Mohanpur-Kamalpur, Pipra pra.pi, Rampur Birta	12
	Total	**21**

Data

Records were analyzed to find the annual number of cases of *Visceral leishmaniasis* by VDC. Time series were produced of the numbers of cases in years preceding intervention and years following intervention. For years preceding intervention, year 0 was taken as 1992, or the first subsequent year in which a case was reported. For years following intervention, year 0 was taken as the year preceding the intervention. In both series, numbers of cases were expressed as a proportion of the number of cases in year 0. For VDCs where intervention was repeated, the series was restarted, using the year before each intervention as year 0.

	1999(10)	0.4					
Bariyarpatti	1995(6)	0.17	0.17	0	0.67	0	
Chandraudayapur	1997(2)	0	0.5				
Devipur	1997(4)	0	0	0.75	0.25		
Gadha	1996(5)	0.4	0.4				
	1999(17)	2.8	0.18				
Hakpara	1994(4)	0	0.25	1	0.5	2	
	2000(10)	0.1					
Itatar	1994(6)	0					
	1996(5)	0					
	2000(2)	0	0	0.2			
Inarwa	1997(3)	0	0.67				
Khirauna	1997(5)	0.2	0.2	0.4	0.2		
Kisanpur	1997(23)	0.5	0.5				
Lahan M.	1995(19)	0.4	0.68	0.61	0.68	0.18	
M pur K pur	1994(1)	1	0				
	1997(2)	0	0.33				
	2000(2)	0					
Madar	1996(25)	0.5					
Pipra pra.pi	1994(4)	0.7	0.67	1.33	1.67	0	1.33
Sanhaitha	1994(2)	0.5	0.5				
	1997(5)	0.6	0.8				
	2000(4)	0.2					
Sitapur pra.ra	1997(3)	1	0.67	1.33			
Summary Table							
Mean cases	1(adjusted)	0.59	0.34	0.70	0.66	0.54	1.33
SD	0	1.32	0.22	0.46	0.48	0.84	-
No of records(n)	30	30	21	8	6	4	1

Table-3: Cases following 1992 or first year with case, in unsprayed VDCs

VDC	Year 0	Cases in subsequent years as a proportion of cases in year 0 (Cases in subsequent year/cases in 0 year)			
		Year 0 + 1	Year 0 + 2	Year 0+3	Year0+4
Asanpur	1992(24)	0.33	0.12	0.04	
Aurahi	1992(2)	3.0			
Bastipur	1993(2)	1.5			
Badhramal	1993(9)	0.22	0.11	0	
Bariyarpatti	1993(16)	0.12			
Chandraudayapur	1992(4)	1.25	0.25	0	0.5
Devipur	1992(26)	0.35	0.5	0.73	0.08
Gadha	1993(2)	1	0.5		
Hakpara	1992(3)	0.33			
Itatar	1992(2)	1			
Inarwa	1993(1)	0	1	0	
Khirauna	1994(2)	1	1.5		
Kisanpur	1993(1)	2	1	6	
Lahan M.	1993(7)	1.71			
Lalpur	1992(11)	0.27	0.09	0	
M.pur K.pur	1992(2)	0.5			
Madar	1992(4)	0	1	1.2	
Pipra pra.pi	1992(7)	1.86			
Rampur Birta	1992(0)	0	0		
Sanhaitha	1992(1)	0			
Sitapur pra.ra	1992(14)	0.14	0.14	0.3	0.14
Summary table					
Mean cases	1(adjusted)	0.79	0.52	0.92	0.24
SD	0	0.81	0.47	1.84	0.17
No. of records(n)	21	21	12	9	3

Values in parentheses indicate the number of cases in 0 year.

Out of 21 VDCs, only 18 were found to be sprayed by different insecticides at different time interval. The cases reported in the year of spray and subsequent year were given in the table 1 and reported cases of *Visceral leishmaniasis* in the same VDCs before intervention, or in infected VDCs without intervention, is tabulated in table-2.

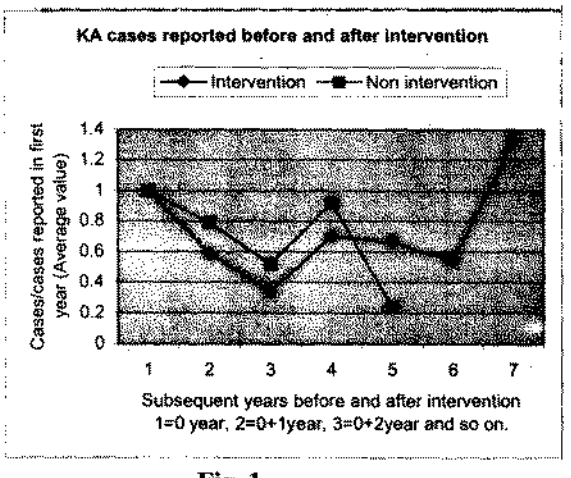

Fig. 1

Simple statistics were used to analyze data. Fig.1 shows the trend of disease reported in the Siraha district hospital before and after intervention and it represents the average values of cases/cases reported in the year of spray from 1992 to 2001. It also presents the average *Visceral leishmaniasis* cases values of 18 VDCs. With the first intervention, the disease burden has been decreased in the subsequent years but after three years the disease intermittently reoccurred and ultimately the number found to be increasing order. The result suggests that there was no long lasting residual effect of spray on disease burden over ten year's period.

In the first year of intervention, the average case/case in the year of intervention was 0.59. It was reduced to 0.34 in following years but after that the value was sharply increased to 1.33 in 6th year of intervention. The pattern of disease suggests similar trend both in intervention and non-intervention groups.

Discussion

When resistance does emerge, the choice of replacement insecticide will depend on the mechanism of resistance, known susceptibility, cost effectiveness and availability. DDT used to be the most commonly applied insecticide and can still be employed where the vectors are susceptible. Where insects are resistant to DDT, the next insecticide of choice is usually one of the organophosphorus

compounds, especially Malathion, Fenitrothion, which are more expensive and more hazardous or Pirimiphos Methyl, the other expensive one, can be used. The Carbamates are also more expensive alternatives. The Pyrethroids are normally used when resistance occurs to all other types of insecticides; they are among the safest products when applied at the recommended dosages (Rozendaal, 1997).

Unfortunately, Nepal has been using the last alternatives Pyrethroids groups of chemicals for the *Visceral leishmaniasis* control program. There is no evidence that the decision were taken with adequate scientific evidences. The shameful fact is that even after the use of such most toxic and most costly insecticides, the disease burden has been gone up and up.

We reviewed the available data on the use of residual insecticides and its effect on *Visceral leishmaniasis* vector in 21 VDCs of Siraha district. However, the limited data of non-intervention period should be acknowledged in this study as the research constrains.

The results showed ineffectiveness of spraying program during the past ten-year period. Contrary to this, the *Visceral leishmaniasis* cases and areas of outbreak have been gradually increased annually. This happened even after the use of most toxic insecticides, Pyrethroid. There are several factors for being poor-success of intervention program. One major factor considered is the short residual effect of the insecticides. Several studies suggest that the susceptible vector reappear after few months of first spray. If the frequent spray is not possible in those foci, the control of this disease is almost impossible (Mukhopadhyay *et al*, 1996). Other possible factors for the poor-success of intervention program might be questionable sprays, diluted pesticide concentration, limited area coverage etc.

Several research works concluded that DDT is still active and sandflies are still susceptible to this insecticide except in few areas. Data on the operational efficacy of DDT/Malathion/Lambdacy-halothrin or other indoor residual spraying against *P.argentipes*, and *P.papatasi* are not available in Nepal. Therefore, it is very difficult to say which insecticide is effective and which one is resistant to sandfly vectors. The government of Nepal has already been practiced most of the available insecticides for the name of *Visceral leishmaniasis* control in the brief time interval. It had used DDT in very first intervention during 1994/95, followed by malathion during 1995/96, Lambdacyhalothrin and K-ornithrine etc. Currently, Lambdacyhalothrine is extensively being used in the *Visceral leishmaniasis* endemic districts of Nepal. This kind of haphazard use of pesticides is one of the severe unfortunates for Nepalese people. The most interesting subject is that the neighboring countries like India and Bangladesh are still believe in DDT, the researcher in these countries are still recommending the use of DDT to control vector. Moreover, WHO has also decided to restore the use of DDT. Then, why the Nepal government emphasizes on subscription of the more toxic and the more costly insecticides? If the government continues to use these kinds of insecticides without proper scientific research, it is definite that the problem of *Visceral leishmaniasis* and other vector borne diseases will increase by many folds in near future. Therefore, this is the right time to review the past episodes of so-called control interventions. Otherwise, the policy makers will have to be accountable to the future generation for the vector control crisis. This can be supported by the fact from the present study of Siraha district, based on the available data of Siraha district public health office where, four different insecticides have been used. Malathion-2 gm/sq.m, varying concentration of Lambdacyhalothrin 0.25, 0.025, 0.0025 gm/sq.m, and k-othrine 0.02gm/sq.m.

The insecticides spraying program, in this district, was started only from 1994 and most interestingly the targeted vector of *Visceral leishmaniasis* in the diseased foci has experienced the taste of four insecticides. This indicates the strong possibility of gaining resistivity against even the most toxic insecticides. However a quality research only can prove this possibility.

Therefore, it is almost impossible to control the target disease, if the authority further extends the present practice of spraying. For the effective vector and disease control, the spray program needs to be continued only after the better assessment of the previous control programs, so that, developing country's poor resources could optimally utilized. This research strongly suggests assessing the insecticidal efficiency of DDT and Malathion before the use of other Pyrethroid compounds.

This is the very first study in Nepal, which has tried to assess the insecticidal effect of in use insecticides and success of government intervention program for *Visceral leishmaniasis* vector control. The authority should know the fact that with the change of costly insecticide, the problem must not reduce. The fate of control program in Nepal, therefore, arises controversy and some unanswered questions.

- Why did the government use different insecticides yearly without strong scientific evidence?
- Available studies have confirmed the insecticidal and cost effectiveness of the DDT in the continent. Therefore, instead replacing such costly and more toxic insecticides, then why Pyrethroid?
- The disease burden hasn't been reduced even after the insecticide spray. Why?
- Why did different concentration of insecticides used in the same area?
- Question can be raised in the method of spraying and area coverage.

Problems with household spraying in *Visceral leishmaniasis* control program

Frequent spraying of the insecticide makes the target insect resistant. Outdoor biting and resting habits of vector sandflies, inadequate sprayable surfaces in some houses and custom of people in some areas to sleep outside during the hot season are burning issues related to disease control. Another important problem was poor acceptance of the method by the community. Population living in areas where house spraying was carried out often did not see much benefit from spray operations. They became increasingly reluctant to allow spray teams to have access to their living quarters and to accept bad-smelling and unsightly insecticide deposits in their houses unless there was a substantial reduction in disease incidence.

Organization of spraying

A community-based approach avoids most of the problems related to the transportation of spray teams and equipment. The cost for personnel is much reduced although the local health services or a community-based organization may have to give the spray workers some financial or other compensation. The health services however have to be strengthened in order to provide health education as well as the supervision and evaluation of activities. The responsibility for equipment, spare parts and insecticide also has to lie with the health services. Vector control experts are needed to provide advice on spraying techniques and equipment, appropriate insecticides and the time of spraying.

Conclusion

Regarding the effectiveness of insecticide spray, the extensive review of ten years data available in Siraha districts public health office showed that spray was not satisfactory in terms of controlling target disease *Visceral leishmaniasis*. Similarly, insecticides have been used haphazardly, with out proper research and other technical feed back. Following are the important points to be noted in the present study. The poor-success might be due to the following reasons:

1. Problem in identifying the areas where insecticide needs to be sprayed.
2. No periodical spray in the identified areas.
3. Technical problem due to lack of skilled man power.
4. Problem due to no or poor community participation.
5. Trend of spray only in those VDCs where VL cases were recorded.
6. Inefficient supervision by peripheral supervisors.

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