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Full Length Research Paper

A new method of kala-azar elimination: shifting the reservoir of infection from that village

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The elimination of kala-azar is a major objective which should be achieved by 2015, one of the objectives of United Nation (UN) Millennium Development Goals. Kala-azar is present in Bihar for more than 100 years. We undertook a study to achieve elimination by adopting a village as a unit of elimination and shifting all patients to a distant place for treatment with an effective drug amphotericin B so that the contact between infected and noninfected population through sandfly is minimized. We selected six villages for elimination, only those villages were selected which were not cared by the government agency and the villagers sought our direct help. The villages were Goanpura in Phulwari block, Sunderpur in Bikram, Tengraila in Naubatpur and Budhura in Barh in Patna district, Banthu in Bhagwanpur of Vaishali district, and Mehsi in Motihari district. It was decided to collect all patients at one place after 3 days of media publicity, rK-39 test was to be done to all patients of fever of more than 2 weeks duration with hepato-splenomegaly, all rK-39 +ve cases were to be transferred to Patna for parasitological confirmation of diagnosis, (parasites in splenic / bone marrow aspirates) and treatment with amphotericin B (AMB) (Fungizone) with all precautions, at a dose of 1 mg/kg body weight intravenous infusion given in 4 hours daily for 20 days and on day 21 splenic aspiration was done to assess the parasite status of patients. It was decided to take help of state government for insecticide spray only which was advertised to be done by the government agencies. In Goanpura 21 cases of kala-azar were identified, shifted to Balaji Utthan Sansthan, Patna for parasitological confirmation of diagnosis and treatment with AMB and were cured, one patient died. Two rounds of supervised DDT spray were done in that village. No new case occurred during 9 years of follow up of that village, no sandfly was detected in 2012 and no case relapsed till 2012. The population of patients mostly belonged to scheduled caste and they were poor. 25 patients detected in 4 camps in which 120 patients were examined, their diagnosis was confirmed parasitologically and they were treated and cured with AMB after shifting them to Patna and kala-azar was eliminated in that village without DDT spray. No sandfly was found in 2012. The population was poor but their housing condition was better as houses were newly built under Indira Awas Yojana. This village inhabited by very poor people with poor living conditions had 30 patients of kala-azar out of 98 patients examined in six camps. All kala-azar cases were cured. We had to organise six camps to eliminate kala-azar from this village, one round of unsupervised spray of DDT was done. Kala-azar was eliminated from that villages. Sandflies were found in Jan 2012. 32 patients of kala-azar were detected in 5 camps out of 124 patients examined. They were treated with AMB and cured. Kala-azar was eliminated from that villages. No sandfly was found in 2012. An unsupervised spray of DDT was done. The population was mixed type, partly of middle class and partly poor. 15 patients detected out of 75 patients examined in two camps. They were treated and cured and one round of good but unsupervised DDT spray was done. Kala-azar was eliminated from that village. The patients belonged to poor Mushar community. No sandfly was found in Jan 2012. They were living in one corner of the village. 97 patients were detected in one camp out of 170 patients examined. They were sent to Patna for treatment and were cured. 6 patients were detected in second

camp and 3 patients were found in 3rd camp in 2012. The disease was controlled in that village. One round of unsupervised DDT spray was done and no sandfly was detected in 2012 Jan. The population was mixed type and a big water body was situated near the village. There was some floating population in that village. Kala-azar was eliminated in 5 villages and controlled in one by adopting a new method of elimination in which all patients were collected at one place and tested with rK-39, rK 39 +ve patients with fever and hepato splenomegaly, were shifted to Patna for parasitological diagnosis and treatment, thus minimizing the contact between infected and noninfected population. In one village Tengrailla kala-azar was eliminated without insecticide spray but more detection camps 4 in number were held for early detection of cases and no spray of DDT or any insecticide was done. In Mehsi the disease was controlled by this method by removing 97 patients in the first camp. Adopting one villages as a unit of elimination and shifting all infected patients to another place for treatment which minimized the contact between infected and non infected population through sandfly and treating the patients with an effective drug amphotericin B at a dose of 1 mg/kg body wt. given as IV infusion for 20 days kala-azar could be eliminated by 2015. The role of insecticide should be reassessed and environment friendly insecticide should be used.

Keywords: village as an unit of elimination- visceral leishmaniasis (kala-azar)- Amphotericin B.

INTRODUCTION

Kala-azar elimination is a major problem in Bihar after polio elimination and has to be achieved by 2015 as one of the United Nation (UN) Millennium Development Goals (United Nations, 2007). Kala-azar is present in Bihar for more than 100 years (Sen Gupta, 2006) with big epidemics occurring in 1977 (Table 1, Figure1) with 100,000 (Dutta and Ghosh, 1983) cases and in 1990 -91 with 250,000 cases (Government of India, 1991) in recent years (Table 1, Figure1). Intensive DDT spray done between 1953 to 1964 for malaria eradication caused almost elimination of kala-azar (Bora, 1999) but it never touched the zero level (figure1). The programme was discontinued in 1964 and cases of chronic kala-azar and PKDL left uncared (Sanyal, 1979). Sandfly returned to the houses (Sengupta, 1975), fed on PKDL cases and there was a big epidemic in 1977 with 100,000 cases (Dutta and Ghosh, 1983), (table 1, Figure 1) with 70 % of the cases present in four districts of Bihar, Vaishali, Muzaffarpur, Sitamarhi and Samastipur. With intensive control programme done between 1977 to 1980, the epidemic was controlled and then there was a relaxation in the programme and another big epidemic occurred in 1990-91 with 250,000 cases (Government of India, 1991) (Table 1, Figure 1). This programme also continued for 4 years only and then there was relaxation in control programme as Bihar Government was unable to contribute its share of 7-crore of Rs. as a part of 28-crore of Rs. programme and rest was to be given by Central Government. The kala-azar cases increased again (figure 1, Table 1). In 2003 when there was an outbreak people from some villages telephoned us for direct help as they

were not receiving any help from government agencies, we started this programme and stopped at six villages because of resource constraint. We proceeded to eliminate kala-azar from those villages according to a protocol prepared by us, the basis of which was one village as an unit of elimination. We report the outcome of that study.

MATERIAL AND METHODS

We took inspiration from the work of Napiers that an infected man is an essential factor in transmission of kala-azar and also from Rogers that cases removed to a different site were better protected (Rogers Sir Leonard). We prepared a protocol incorporating these ideas and worked accordingly.

We thought that shifting of all infected persons to a distant place Patna for treatment would minimize the reservoir of infection in that village and minimize further chance of infection to non-infected persons.

Protocol

- a. Collection of patients of fever of affected village at one place, in a school or community hall after 3 days of mike publicity.
- b. A febrile patient with hepato-splenomegaly of more than 2 weeks duration was tested with rK-39 (Maia et al., 2012; Salotra et al., 2002). All rK-39 positive cases were transferred to Patna for confirmation of diagnosis and treatment.
- c. The routine total and differential count of WBC, Platelet count, prothrombine time, Hb, blood urea, serum creatinine and serum electrolytes were done in each case

d. Splenic aspiration/was done through intercostals route and the blood slides were stained with Giemsa and parasites were searched under oil immersion (Thakur, 1997).

e. The parasite positive cases were treated with amphotericin B (R Fungizone) only at a dose of 1/mg/kg body wt. daily given slowly in 4 hours for 20 days (Thakur et al., 1996; Thakur et al., 1999). A bottle of normal saline and potassium chloride 20 ml were given before each infusion. All precautions were taken to prevent the drug toxicity of amphotericin B (Thakur, 1998; Chandeshwar et al., 2010). The different preparations of amphotericin B available in the market were tested for their efficacy and Fungizone was found the best.

f. The splenic aspiration was done on day 21.

g. The patients were discharged on day 21.

h. The patients were asked to come every month for six months and then was asked to come if he got fever for follow up.

i. The district authorities were requested to do two rounds of supervised DDT spray as they were doing for whole Bihar. In this spray programme it was requested that one member of our team should supervise the spray if he was permitted by the authority.

j. The entomological study was done before the start and at the end of study i.e. in 2012 January by experts of Rajendra Memorial Research Institute, Patna.

k. The figures of kala-azar cases of whole Bihar were noted from the Malaria Office of Government of Bihar. Patna.

l. The follow up of different villages were planned according to number of cases reported from that village. The early detection of cases was part of the protocol. The drug for treatment was made available from Balaji Utthan Sansthan and some help from department of Biotechnology, Government of India.

RESULTS

Table 1 shows number of cases of kala-azar and PKDL from 1977 to 2011 and the effect of control measures on the incidence of disease.

In 1977 epidemic 100,000 cases were detected by a survey done by National Malaria Eradication Programme whereas records of Primary Health Centres showed only 18,589 cases. Similarly in 1991 250,000 cases were detected by a survey team appointed by government of India whereas record of PHC showed only 75,523 cases.

Figure 1 shows number of cases of kala-azar from 1977 to 2011. Kala-azar cases never touched the zero level. If there was relaxation in the programme the number of cases increased again after few years. PKDL cases shows considerable decline when amphotericin B was extensively used in the treatment of kala-azar.

Table 2 shows outcome of control programme in six villages between 2003 to Jan 2012 which were studied by

us. The preliminary result of Goanpura was reported earlier (Thakur et al., 2009) Each village presented a different picture. In Goanpura after 1st detection camp no case occurred. All cases were transferred to Patna for treatment. Except one case who was very weak died and the rest of the cases were cured. Two rounds of supervised DDT spray were done. There was no relapse of any case till Jan 2012. No sandfly was detected in Jan 2012. We could not arrange for their better houses.

Tengraila: The total numbers of cases detected were only 25 but no DDT spray was done in that village and the village became kala-azar free without DDT spray. No sandfly was found in 2012. 4 camps were held for early detection of new cases. They were poor but their houses were recently constructed under Indira Awas Yojna therefore they were not so shabby.

Sunderpur:-30 cases of kala-azar were detected. They were all treated at Patna and cured. One round of unsupervised spray of DDT was done. Sandflies were found at the end of treatment in Jan 2012. It took longer time to eliminate kala-azar from this village. The patients were poor and their living conditions were unsatisfactory. We had to arrange for five camps for early detection of cases.

Budhura: 32 cases of kala-azar were found in five camps and cured. One round of unsupervised spray of DDT was done. All detected cases were treated at Patna and cured. Kala-azar was eliminated more by frequent detection and treatment in that village. The patients were economically better no doubt but some were poor and some were of middle class.

Banthu: 15 cases of kala-azar 13 in first lot and 2 in second batch were detected and cured. One good spray of DDT was done and village became disease free. Kala-azar was present in poor Mushahar community in that village and they were localized to one segment of the village. All patients were transferred to Hajipur hospital and treated and cured.

Mehsi: This village had larger number of cases, 97 cases at first lot, 6 and 3 each in the second and third lots, a total of 106 patients were detected and treated at Patna and 3 patients were being treated in 2012 in local hospital. One round of unsupervised DDT spray was done in that village. The population was of mixed type and there were some floating population also. There was a big water body near the village.

Table 3 shows the district wise kala-azar cases and deaths from kala-azar between 2006-2011. (Government of Bihar's figure). It shows that number of cases of kala-azar is increasing since last 3 years. This is a question of concern.

Table 4 Shows the kala-azar cases in Primary health centres in 2011 in different affected districts of Bihar. The four districts- Muzaffarpur, Sitamarhi, Vaishali and Samastipur were heavily affected in 1977, 1991-92 and all primary health centres of these four districts were affected then and are affected in 2011 also.

Table 1. Shows total no. of cases of kala-azar in Bihar between 1977 and 2011 (Figures from kala-azar Department of Government of Bihar) and PKDL patients admitted to PMCH. (Patna Medical College Hospital) and of one survey done by Dept. of Malaria control of Govt. of India in 1977 and one by department of health govt. of India in 1991.

Year	PKDL cases in Bihar	Kala-azar cases in Bihar
1977	13	100000
1978	15	41980
1979	27	25472
1980	28	13620
1981	27	14165
1982	28	11120
1983	30	11830
1984	35	12985
1985	48	13029
1986	52	14979
1987	50	19179
1988	55	19639
1989	59	34489
1990	14	54650
1991	20	250000
1992	22	75523
1993	10	44155
1994	17	24391
1995	18	21045
1996	14	25056
1997	14	15948
1998	14	12441
1999	12	11627
2000	5	12909
2001	15	10237
2002	10	9184
2003	5	13960
2004	4	17324
2005	4	21177
2006	1	29711
2007	17	37822
2008	7	29094
2009	NA	21318
2010	1	23084
2011	9	25178

Table 2. show the results of six studied villages from 2003 to January 2012.

Sr. No.	Village (district, block)	No of cases detected	Supervised DDT spray done	Final status in Jan 2012	Entomological status in Jan 2012
1.	Goanpura (Patna, Phulwari) (S)	39, One case died	2 supervised sprays	No new case after 39 cases of kala-azar. Yearly camps were done 2 cases in 2012.	No sandfly detected
2.	Dhuparchak(C) Tengrailla (Patna, Naubatpur)	12 cases detected. 25 cases in 4 camps	No Supervised spray. No spray		
3.	Sunderpur (Patna, Bikram)	30 cases in 5 camps	One unsupervised spray	Last one case in Dec. 2011	Sandfly detected in that village.
4.	Budhura (Patna, Barh)	32 cases in 5 camps	One unsupervised spray	No case in Jan 2012	No Sandfly detected
5.	Banthu, (Vailashi, Bhagwanpur)	15 cases in 2 camps	One unsupervised spray but good spray	No case for the last 3 years	No sandfly
6.	Mehsi, (East Champaran, (Mehsi)	106 cases in 3 camps	One unsupervised spray	3 cases in 2012 but cure.	No sandfly

Table 3. District wise Kala-azar Cases and Deaths of Year 2006-2011

SL.NO.	Name Of District	2006		2007		2008		2009		2010		2011	
		CASE	DEATH	CASE	DEATH	CASE	DEATH	CASE	DEATH	CASE	DEATH	CASE	DEATH
1	Araria	2587	0	3937	6	2382	5	1575	3	2037	0	1792	0
2	Arwal	6	0	7	0	4	0	2	0	2	0	1	0
3	Aurangabad	0	0	0	0	0	0	0	0	0	0	0	0
4	Banka	0	0	0	0	2	0	2	0	0	0	1	0
5	Begusarai	874	15	757	34	479	12	272	4	293	5	351	2
6	Bhagalpur	185	4	101	0	100	0	47	2	105	4	170	4
7	Bhojpur	69	5	31	1	24	2	7	0	15	0	21	0
8	Buxar	9	0	3	0	10	0	50	2	10	0	14	0
9	Darbhanga	728	6	1246	6	1497	4	947	1	1019	0	1121	0
10	E.Champaran	1614	19	3182	19	2064	12	1365	5	1280	14	1399	6
11	Gaya	0	0	0	0	0	0	0	0	0	0	0	0
12	Gopalganj	1331	1	1574	0	1136	1	767	0	877	0	930	0
13	Jamui	0	0	0	0	0	0	0	0	0	0	0	0
14	Jehanabad	15	0	28	0	11	0	19	0	14	0	24	0
15	Kaimur	0	0	0	0	0	0	0	0	0	0	0	0
16	Katihar	895	5	1096	14	744	9	532	5	708	8	927	8
17	Khagaria	780	0	236	0	588	0	309	0	329	0	349	0
18	Kishanganj	135	0	208	0	214	0	128	1	167	0	222	0
19	Lakhisarai	24	0	25	0	22	0	5	0	15	0	62	0
20	Madhepura	2245	0	2692	0	1999	2	1591	3	1721	3	1520	4
21	Madhubani	1026	3	1116	1	1013	3	732	2	630	2	543	2
22	Munger	61	0	23	0	78	0	40	1	60	1	104	2
23	Muzaffarpur	3966	32	4660	36	3679	38	2329	11	2573	22	2782	18
24	Nalanda	110	1	63	0	42	0	13	2	11	0	18	0
25	Nawada	1	0	0	0	0	0	61	4	17	0	32	0
26	Patna	499	25	310	6	197	5	133	2	141	4	170	3
27	Purnea	1379	2	1890	2	2016	1	2138	1	2238	8	2232	1
28	Rohtas	0	0	0	0	0	0	0	0	0	0	0	0
29	Saharsa	2054	6	3826	4	2505	7	2150	5	2230	5	2191	4
30	Samastipur	1389	6	1817	6	1922	9	1158	3	1261	1	1233	2
31	Saran	1652	2	2139	9	1596	4	1055	2	1103	1	1733	4
32	Sheikhpura	1	0	1	0	0	0	0	0	0	0	58	1
33	Sheohar	142	0	208	0	127	1	110	0	95	0	222	0
34	Sitamarhi	897	10	1168	19	847	24	726	15	934	8	1294	12
35	Siwan	700	0	999	0	754	0	660	0	715	1	786	0
36	Supaul	622	0	817	2	16	4	386	1	396	0	352	0
37	Vaishali	2972	18	3275	6	2787	3	1883	4	1989	7	2421	3
38	W.Champaran	743	2	387	1	239	1	126	1	99	1	103	0
Total		29711	162	37822	172	29094	147	21318	80	23084	95	25178	76

There was increase in number of cases of kala-azar from 2009.

Table 4. Kala-azar in Bihar Primary Health Centre wise in 2011

REVISED FINAL MONTHLY KALA-AZAR REPORT OF 2011																		
STATE : BIHAR																		
Sl.No	Name of the District	No. of PHCs		Population of affected PHCs	Report up to Previous Month			Reported during the Month			Progressive Total			Cases under treatment	Untreated Cases	Resistant Cases	PKDL Cases	Remarks
		Total	Affected		Cases	Deaths	Treated	Cases	Deaths	Treated	Cases	Deaths	Treated					
		3	4		6	7	8	9	10	11	12	13	14					
1	Araria	9	9	0	1716	0	873	76	0	300	1792	0	1173	619	0	0	0	tele
2	Arwal	3	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	rec
3	Aurangabad	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	rec
4	Banka	10	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	rec
5	Begusarai	11	10	0	328	2	297	23	0	24	351	2	321	28	0	0	0	rec
6	Bhagalpur	11	9	0	161	4	126	9	0	15	170	4	141	18	6	0	1	rec
7	Bhojpur	12	3	0	20	0	17	1	0	3	21	0	20	1	0	0	0	rec
8	Buxar	7	2	0	14	0	14	0	0	0	14	0	14	0	0	0	0	rec
9	Darbhanga	16	15	0	1035	0	881	86	0	79	1121	0	960	98	40	23	0	rec
10	E.Champaran	20	18	0	1324	6	1226	75	0	81	1399	6	1307	86	0	0	0	rec
11	Gaya	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	rec
12	Gopalganj	14	13	0	889	0	845	41	0	49	930	0	894	15	0	0	21	rec
13	Jamui	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	rec
14	Jehanabad	7	4	0	20	0	19	4	0	5	24	0	24	0	0	0	0	rec
15	Kaimur	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	rec
16	Katihar	17	17	0	843	8	721	84	0	113	927	8	834	53	30	0	2	rec
17	Khagaria	8	7	0	324	0	267	25	0	30	349	0	297	52	0	0	0	tele
18	Kishanganj	7	7	0	211	0	192	11	0	18	222	0	210	11	1	0	0	rec
19	Lakhisarai	6	4	0	61	0	59	1	0	0	62	0	59	1	2	0	0	rec
20	Madhepura	13	13	0	1456	4	1197	64	0	146	1520	4	1343	125	47	0	1	rec
21	Madhubani	18	18	0	506	2	467	37	0	37	543	2	504	36	1	0	0	rec
22	Munger	6	4	0	99	2	97	5	0	4	104	2	101	1	0	0	0	rec
23	Muzaffarpur	16	16	0	2667	18	2331	115	0	331	2782	18	2662	99	0	3	0	rec
24	Nalanda	20	9	0	16	0	15	2	0	3	18	0	18	0	0	0	0	rec
25	Nawada	10	1	0	32	0	32	0	0	0	32	0	32	0	0	0	0	rec
26	Patna	23	16	0	156	3	147	14	0	17	170	3	164	2	0	0	1	rec
27	Purnea	14	14	0	2142	1	1980	90	0	156	2232	1	2136	94	0	1	0	rec
28	Rohtas	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	rec
29	Saharsa	10	9	0	2079	4	1749	112	0	182	2191	4	1931	223	26	0	7	rec
30	Samastipur	16	16	0	1174	2	1108	59	0	95	1233	2	1203	26	2	0	0	rec
31	Saran	15	15	0	1642	3	1555	91	1	107	1733	4	1662	64	0	0	3	rec
32	Sheikhpura	6	3	0	58	1	53	0	0	1	58	1	54	1	3	0	0	tele
33	Sheohar	5	4	0	213	0	198	9	0	15	222	0	213	9	0	0	0	by vbd
34	Sitamarhi	13	13	0	1216	12	1036	78	0	98	1294	12	1134	111	37	0	0	rec
35	Siwan	19	19	0	743	0	674	43	0	69	786	0	743	43	0	0	0	rec
36	Supaul	11	10	0	320	0	289	32	0	27	352	0	316	36	0	0	0	tele
37	Vaishali	16	16	0	2283	2	2245	138	1	128	2421	3	2373	45	0	0	0	rec
38	W.Champaran	16	11	0	99	0	78	4	0	11	103	0	89	13	0	0	1	rec
TOTAL		470	326	0	23848	74	20789	1330	2	2145	25178	76	22934	1910	195	27	37	

No of district affected 32 out of 38.

No of PHC affected:

All PHC affected = no of districts = 12

More than 75% of PHC affected = no of district = 9

More than 50% of PHC affected = no of district = 4

Less than 50 % of PHC affected = 7

There was increase in number of cases in 2011 compared to 2009 and 2010.

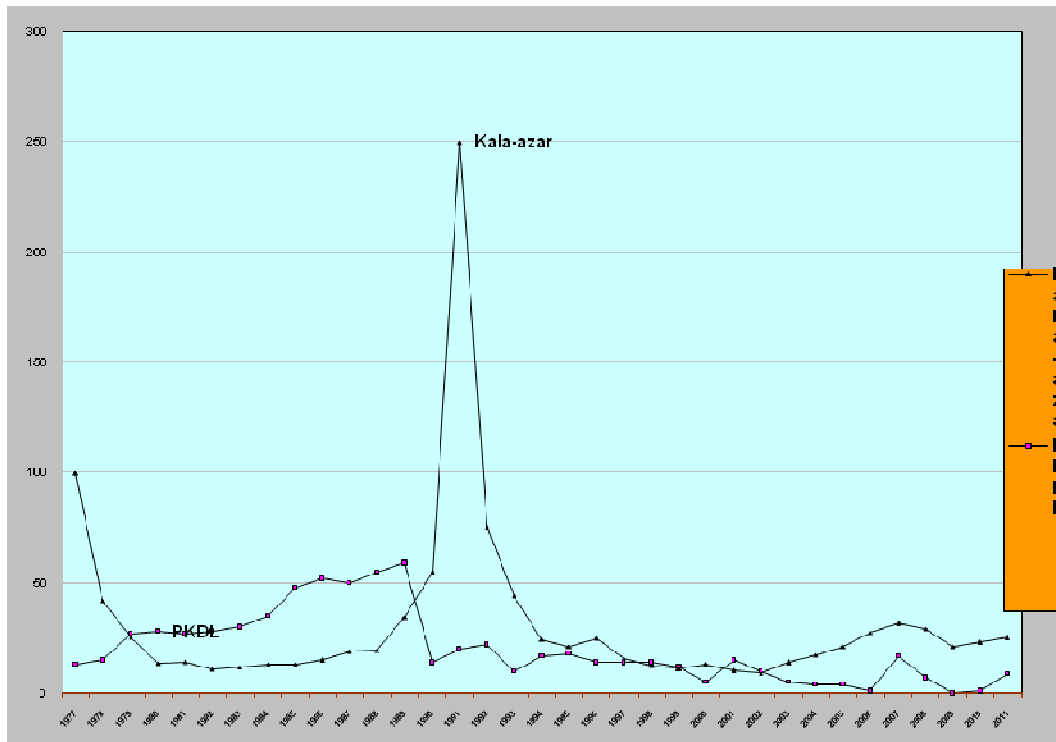


Figure 1. Showing relation of kala-azar cases and PKDL between 1977 and 2011

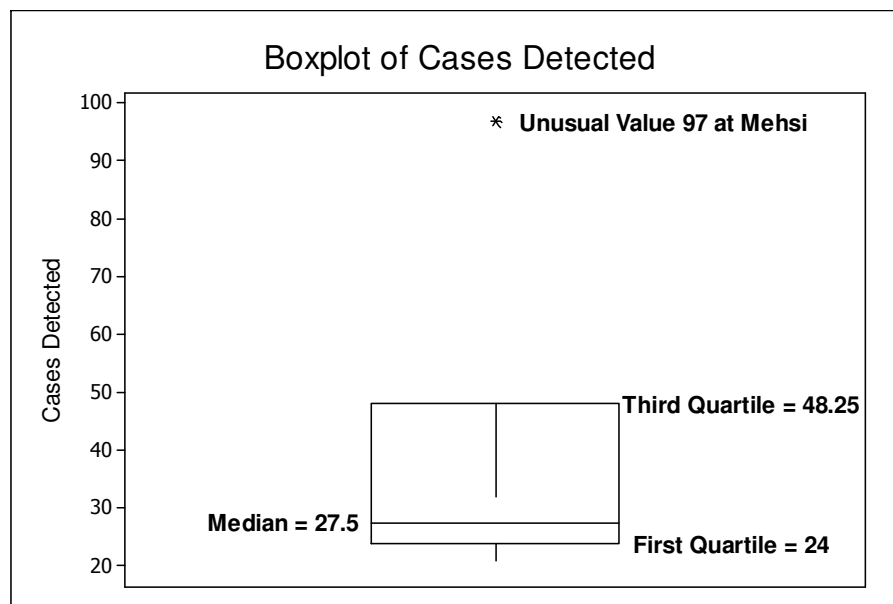


Figure 2. Boxplot of the Kala-azar cases detected in six villages between 2003 and Jan 2012

Statistical Analysis of the results

The statistical analysis (Figure 2) of Table 1 reveals that a very high unusual (outlier) value of persons suffering from the disease in January 2004 was detected at

Mehsi (East Champaran) as compared with other places that include Goanpura (Patna), Tengraila (Patna), Sunderepur (Patna), Budhura (Patna), Banthu (Vaishali).

A trend analysis was carried out for understanding the nature of the pattern of district wise Kala-azar cases and

Table 2a. Trend analysis of Kala-azar cases reported in districts of Bihar during 2006-2011

Districts	Fitted Trend Equation	Nature of Annual Growth
Araria	3433-299.5*t	Decreasing
Begusarai	926-120.4*t	Decreasing
Bhagalpur	129.6-3.3*t	Decreasing
Bhojpur	58.3-8.7*t	Decreasing
Buxar	7.4+2.5*t	Increasing
Darbhanga	1020+21.1*t	Increasing
E. Champaran	2565-213.7*t	Decreasing
Gopalganj	1576-144.7*t	Decreasing
Jahanabad	17.4+0.3*t	Increasing
Katihar	930-34.7*t	Decreasing
Khagaria	647-61.6*t	Decreasing
Kishanganj	156.4+6.5*t	Increasing
Lakhisarai	11.2+4.1*t	Increasing
Madhepura	2656-198.5*t	Decreasing
Madhubani	1258.7-118.7*t	Decreasing
Munger	32.2+8.2*t	Increasing
Muzaffarpur	4685-386.6*t	Decreasing
Nalanda	107.3-18.4*t	Decreasing
Nawada	-8.2+7.6*t	Increasing
Patna	463.3-63.3*t	Decreasing
Purnia	1439+155*t	Increasing
Saharsa	2938-127.4*t	Decreasing
Samastipur	1785-91.8*t	Decreasing
Saran	1871-92.7*t	Decreasing
Sheikhpura	-18.2+8.1*t	Increasing
Sheohar	146.3+1.3*t	Increasing
Sitamarhi	861+33.2*t	Increasing
Siwan	821-14.7*t	Decreasing
Supaul	656-64.1*t	Decreasing
Vaishali	3306-214.8*t	Decreasing
W. Champaran	701-119.3*t	Decreasing
Total	35167-2133.0*t	Decreasing

deaths during 2006-2011 given in Table 2. Out of 38 districts of Bihar seven districts that include Arwal, Aurangabad, Banka, Gaya, Jamui, Kaimur and Rohtas were not considered for the analysis because of either no or a very few Kala-azar cases were reported in these districts. Table 2a provides the fitted linear trend equation as well as the nature of the annual growth between 2006 and 2011. Twenty (64.5%) districts show a decreasing trend while 11 (35.5%) districts reveal an increasing trend in this period. Figure 2a depicts the trend analysis plots for the total Kala-azar cases and the deaths in these cases during 2006-2011. These plots reveal a declining trend. The fitted trend equations for the total Kala-azar cases and the total deaths based on 38 districts are obtained as $35167-2133.0Xt$ and $194.8-20.8Xt$ respectively, which point to a declining trend during 2006 to 2011.

But Table 2 indicates a more disturbing trend on considering the figures of the Kala-azar cases for the period between 2009 and 2011. The linear trend analysis (Table 2b) presents that out of 31 districts 25 (80.6%) districts reveal a rising trend while only 6 (19.4%) districts show a declining trend. The predicted values of the cases

in 2012 and 2013 are also mentioned using the fitted trend equations. In view of the scenarios the policy and decision makers must intervene to contain the spread of the disease and to accomplish the UN Millennium Development Goal 6 and the Target 6C by 2015. Figure 4 portrays the alarming situation of the disease in Bihar. The trend analysis plots for total Kala-azar cases and deaths during 2009-2011 are given in Figure 5, which depicts a very high growing trend of the cases while a marginally falling trend for deaths. For predicting the Kala-azar cases in 2012, one needs to put $t = 2012-2008 = 4$ in $19333+1930Xt$ that yields the estimated number of cases as $19333+1930X4=27053$. The incidence of the disease could rise to 28983 in 2013 if the trend is allowed to continue uninterrupted.

The total number of Kala-azar cases and the number of PKDL patients admitted to the Patna Medical College and Hospital (PMCH) between 1977 and 2011 are provided in Table 3. Figure 6 reveals that unusually high values for Kala-azar cases were recorded in 1977, 1991 and 1992 while 1989 witnessed an unusual high value for the PKDL cases. The trend analysis plots for the total Kala-azar and the PKDL cases are presented in Figure 7, which shows

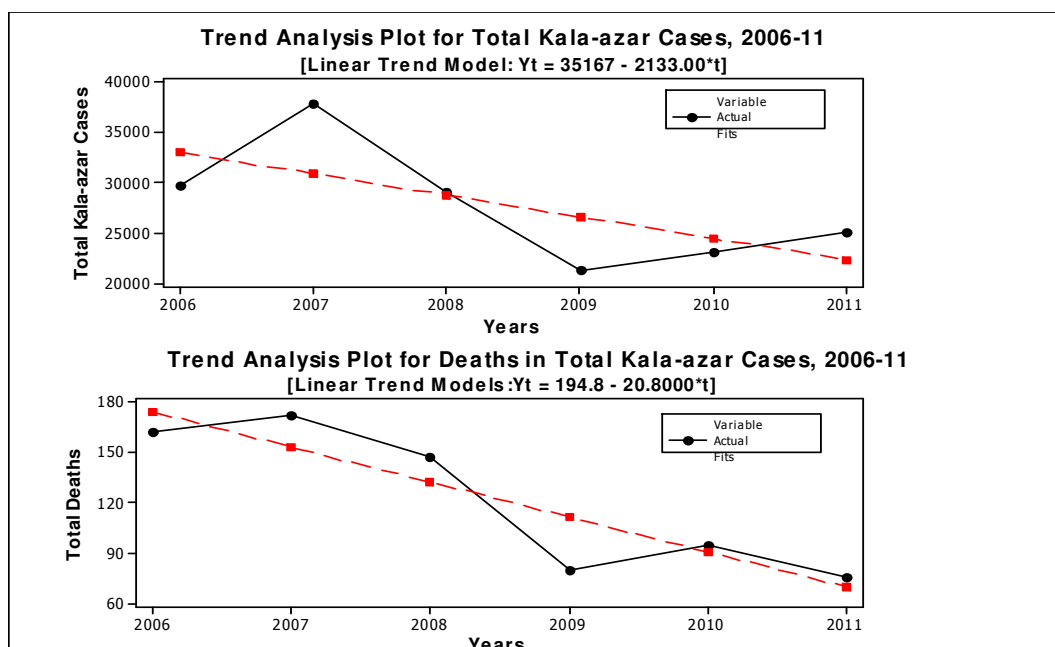


Figure 3. Trend analysis plot for total Kala-azar cases and deaths in these cases during 2006-2011

Table 2b. Trend analysis of Kala-azar cases reported in districts of Bihar during 2009-2011

Districts	Fitted Trend Equation	Nature of Annual Growth	Predicted Cases in 2012	Predicted Cases in 2013
Araria	$1584+108 \cdot t$	Increasing	2016.00	2124.00
Begusarai	$226.3+39.5 \cdot t$	Increasing	384.30	423.80
Bhagalpur	$-15.7+61.5 \cdot t$	Increasing	230.30	291.80
Bhojpur	$0.33+7 \cdot t$	Increasing	28.33	35.33
Buxar	$60.7-18 \cdot t$	Decreasing	-11.30	-29.30
Darbhanga	$855+87 \cdot t$	Increasing	1203.00	1290.00
E. Champaran	$1314+17 \cdot t$	Increasing	1382.00	1399.00
Gopalganj	$695+81.5 \cdot t$	Increasing	1021.00	1102.50
Jahanabad	$14+2.5 \cdot t$	Increasing	24.00	26.50
Katihar	$327.3+197 \cdot t$	Increasing	1115.30	1312.30
Khagaria	$289+20 \cdot t$	Increasing	369.00	389.00
Kishanganj	$78.3+47 \cdot t$	Increasing	266.30	313.30
Lakhisarai	$-29.7+28.5 \cdot t$	Increasing	84.30	112.80
Madhepura	$1682-35.5 \cdot t$	Decreasing	1540.00	1504.50
Madhubani	$824-94.5 \cdot t$	Decreasing	446.00	351.50
Munger	$4+32 \cdot t$	Increasing	132.00	164.00
Muzaffarpur	$2108.3+227 \cdot t$	Increasing	3016.30	3243.30
Nalanda	$9+2.5 \cdot t$	Increasing	19.00	21.50
Nawada	$65.7-14.5 \cdot t$	Decreasing	7.70	-6.80
Patna	$111+18.5 \cdot t$	Increasing	185.00	203.50
Purnia	$2108.7+47 \cdot t$	Increasing	2296.70	2343.70
Saharsa	$2149.3+20.5 \cdot t$	Increasing	2231.30	2251.80
Samastipur	$1142.3+37.5 \cdot t$	Increasing	1292.30	1329.80
Saran	$619+339 \cdot t$	Increasing	1975.00	2314.00
Sheikhpura	$-38.7+29 \cdot t$	Increasing	77.30	106.30
Sheohar	$30.3+56 \cdot t$	Increasing	254.30	310.30
Sitamarhi	$416.7+284 \cdot t$	Increasing	1552.70	1836.70
Siwan	$594.3+63 \cdot t$	Increasing	846.30	909.30
Supaul	$412-17 \cdot t$	Decreasing	344.00	327.00
Vaishali	$1560+269 \cdot t$	Increasing	2636.00	2905.00
W. Champaran	$132.3-11.5 \cdot t$	Decreasing	86.30	74.80
Total	$19333+1930 \cdot t$	Increasing	27053	28983

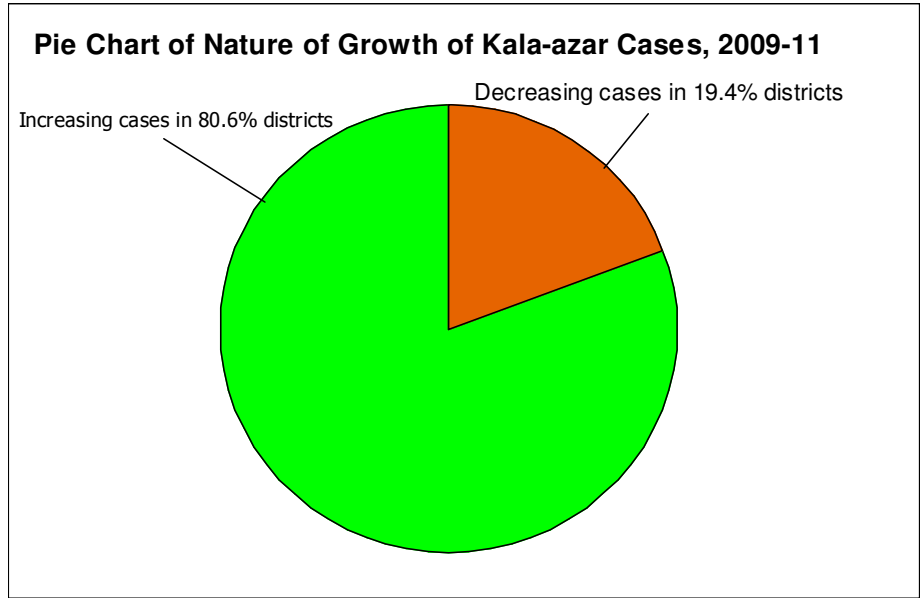


Figure 4. A pie chart of the nature of the annual growth of the Kala-azar cases during 2009-2011.

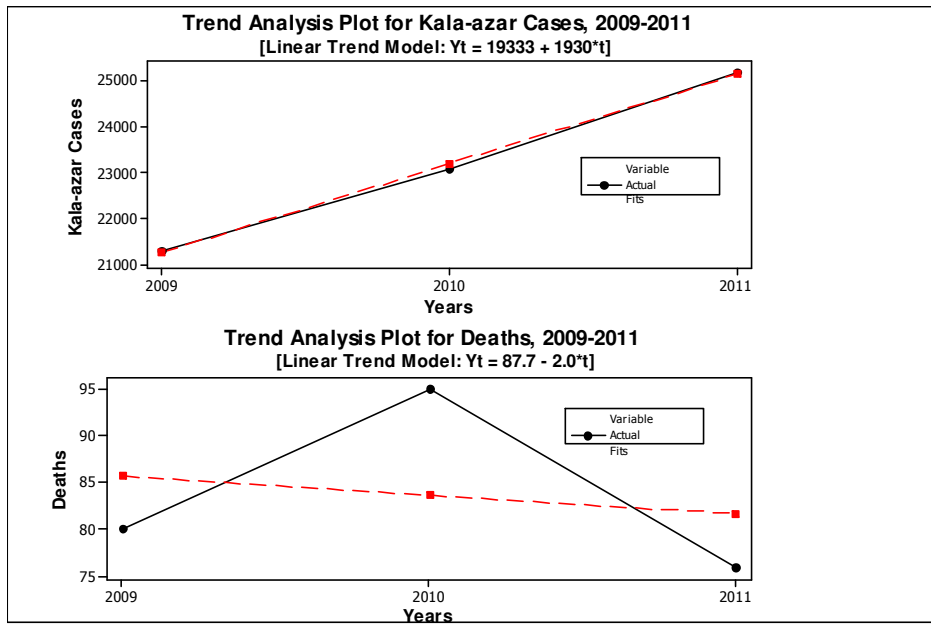


Figure 5. Trend analysis plots for total Kala-azar cases and deaths during 2009- 2011

a declining trend for both the diseases. But it is not a correct finding in view of the result mentioned in Table 2b.

Table 4 provides the information about the incidence of Kala-azar cases in Bihar at the primary health centres (PHCs) level. The findings reveal that 69.4% of the PHCs of the 38 districts of Bihar are infected by it. All (100%) PHCs of 12 districts, more than 75% but less than 100 % of 9 districts, more than 50% but up to 75% of 5 districts, and up to 50% PHCs of 6 districts are affected by the

disease. On considering the level of the treated cases Araria shows the least treated cases (65.1%) of Kala-azar while in 9 districts treated cases vary between 82% to 90%, 17 districts have more than 90% but less than 100% treated cases and 6 districts show 100% treated cases. The Kala-azar-free districts included Aurangabad, Gaya, Jamui, Kaimur and Rohtas. The analysis points to undertake more vigorous steps to eliminate the disease to accomplish the target of the UN Millennium Goal by 2015.

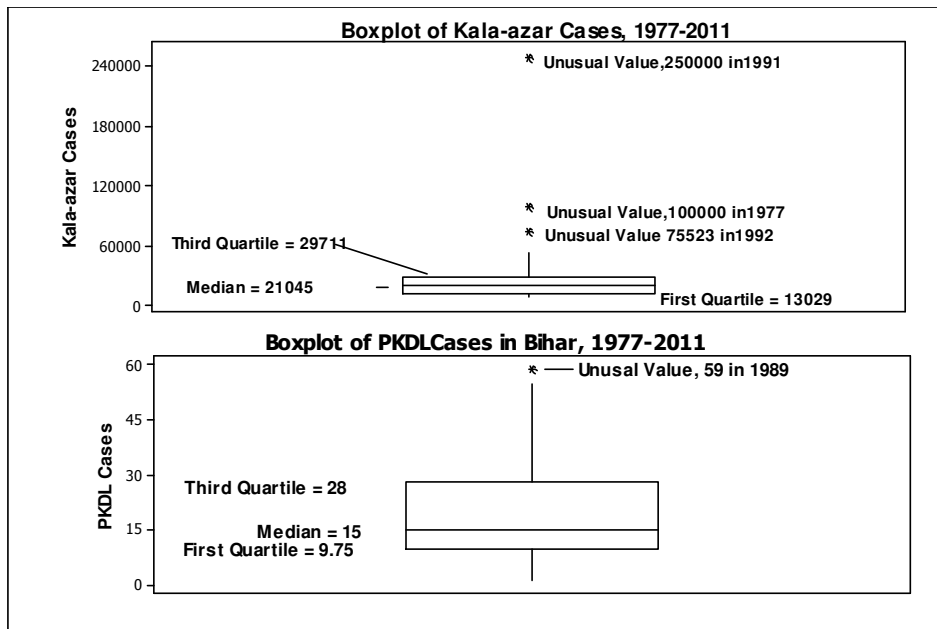


Figure 6. Boxplots of Kala-azar and PKDL cases during 1977-2011

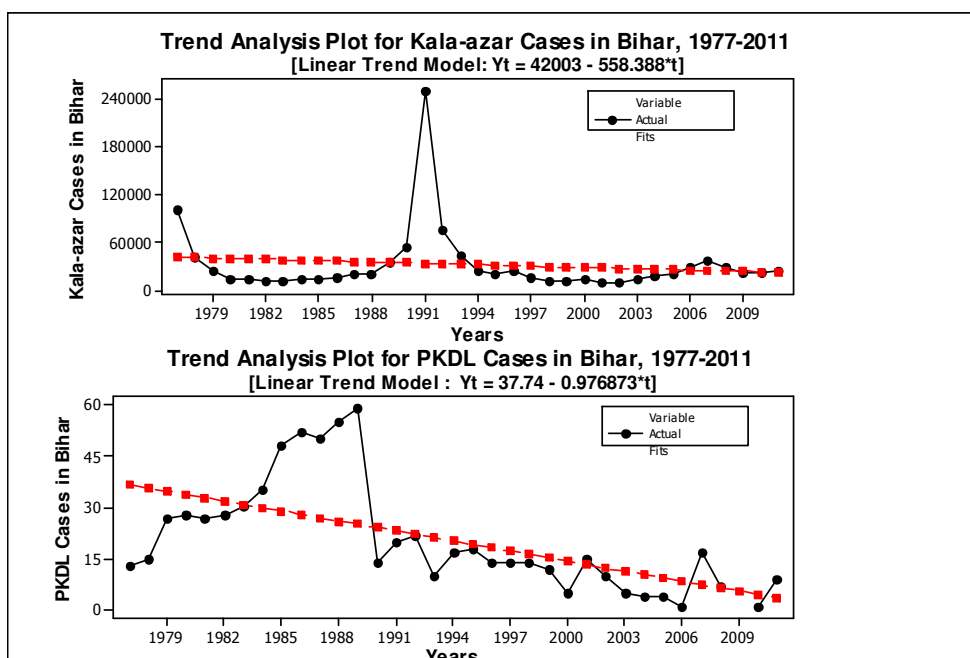


Figure 7. Trend analysis plots for total Kala-azar and PKDL cases during 1977-2011

DISCUSSION

This study showed that kala-azar in Bihar could be eliminated by adopting one village as an unit of elimination, collecting all patients at a time at a common place, shifting all patients to a distant place for parasitological confirmation of diagnosis and treatment with amphotericin B. In the meantime that village should

be sprayed with a safer insecticide for sandfly control under some supervision. We had no other choice than DDT but DDT was found in the underground water of some of the sprayed areas and water of River Ganges also. Therefore rethinking is needed on the choice of insecticide.

In this study Goanpura met all the criteria set in the protocol like publicity, testing the patients with rk 39,

shifting all the patients to Patna and then two rounds of supervised DDT spray of that village, no patient relapsed (it might be a chance). But we seldom see relapse with our regimen of treatment with AMB and no new case was detected and no sandflies was found in 2012. There was no change since preliminary report¹⁷ in spite of annual checkup camps, last one in January 2012.

So far kala-azar control is concerned Tengrailla was even better. Kala-azar was eliminated without DDT spray but we had to hold more detection camps for early detection of cases and their transfer to Patna for treatment. The experience of this village showed that kala-azar could be eliminated without DDT spray. It was also felt that more efforts have to be made for early detection of cases as we did here and finally extended this observation to other villages. In Banthu, Budhura and Sunderpur the disease was eliminated by holding more camps and early detection of cases and treatment. The DDT spray done was unsupervised. Only one round of unsupervised DDT spray was done in all those villages. In Sunderpur we also had to hold more camps for detection of cases as the living conditions were poor and sandflies were present till end. We felt that improvement in living conditions of the poor people in villages with better housing condition and also better surrounding will also facilitate elimination. We have not been able to emphasize this aspect of kala-azar control to the planner. Even money wasted in MANREGA could have been better utilized by providing better housing facility for poor kala-azar patients.

Mehsi case was different, here heavy infection could be controlled by this method by removing the bulk of cases to a different place and with further two attempts cases were brought to a level of 3 patients.

In all the five villages one unsupervised spray of DDT was done. Its utility needs further evaluation in the light of new experience.

Feasibility: Could this method be applied to whole of Bihar? 33 out of 38 districts are affected in Bihar and 25439 villages are present in the affected districts (Tables 1, 2). All districts are not equally affected. In one district there are about 200 doctors and two thousand paramedical and non medicals employees with the government agency. In one village 3 days of publicity is needed. It can be done by one person or even it can be hired. It has to be done in a jeep with a mike and one person could do it. On camp day at least one doctor with one paramedical and two non medical assistants are needed. The doctor will examine the patients. and one paramedical will do rk-39 test. One or two big vehicles like bus would be needed to transport the patients to a distant place, where facilities to do splenic/ bone marrow aspiration, to stain the slides with Giemsa, and a microscope to study the slides should be available. For treatment of kala-azar cases, the drug amphotericin B (R Fungizone), infusion sets, 5% glucose, normal saline potassium chloride and dexamethasone to tackle any

emergent reaction should be available. There should be sufficient space to accommodate at least 100 persons at a time for 20 days. Any medical collage, district or subdivisional hospital can handle that number of patients. Bihar has got 8 government medical colleges, 2 private medical colleges and one Central Government's Institute exclusively devoted to kala-azar Rajendra Memorial Research Institute of Government of India in Patna and two private Medical College Hospitals. Therefore the infrastructure and manpower are enough to tackle this problem. The cheapest and best drug Fungizone should be made available. There should not be any shortage of this drug as happened recently. We compared many preparations of amphotericin B and found fungizone as the best both on amastigotes and promastigotes. Therefore we chose this drug. During last few years the effective drugs were not available. That might be one of the reasons for increase in number of cases of kala-azar since last three years (Table 1, Figure 1). We see sperts of rise in PKDL cases recently which might be due to increasing use of sodium antimony gluconate recently during the period of shortage of effective drug (Thakur et al., 2008; Samiran et al., 2007). We are not paying attention for the treatment of PKDL which requires longer duration of treatment. The disappear once of the lesions showed be criteria of cure of PKDL. Fortunately we do not get any case of PKDL in our series treated with effective regimen of AMB.

Role of insecticide: Recently there was a seminar on toxic substances found in eatables. It was shown by a scientist that ground water of the locality where DDT spray was done and even water of the river Ganges are contaminated with DDT. Therefore we should opt for some safer insecticide or no insecticide. This study has shown that in one village Tengrailla we eliminated kala-azar without DDT and in other 4 villages the DDT was sprayed without our supervision and we expected that much less DDT had been sprayed in those villages and treatment of patients played a major role in elimination. Goanpura was the only village where two rounds of DDT were sprayed under our supervision. No doubt, the disease was controlled in a shorter duration and only one camp was needed. In rest of the villages when we found the DDT spray was not possible as we liked we had to hold more camps to detect the cases in early stage and by treating them we eliminated the chance of spread of the disease to other persons. With little resources available to us this method helped us to eliminate the disease from five villages and to control in one village. We did it with great determination. Therefore if we make the year 2013 as target year for elimination of kala-azar even with or with insecticide, we can reach our goal of elimination by 2015. On epidemic situation, if we analyze Table 2 and statistical analysis table 2b we find that disease is increasing year by year since last 3 years in spite of the best efforts by the central and state governments. But this is the story since last 100 years. If

we want to change the story we have to become more determined and aggressive in our approach as we did in case of polio elimination. We took up villages by village elimination programme we achieved elimination in five villages and controlled the disease in one village. If we examine table 4, there are 25 districts affected, if in which more than 75 with more than 50% PHC affected they need urgent attention. If we take all affected districts 25439 villages are affected. With available man power and hospital facilities we can take up this programme of elimination of kala-azar village by village.

In table 4 there are 12 districts including Vaishali, Muzaffarpur, Sitamarhi and Samastipur where all PHC's are affected in 2011, in these four districts they were also affected in 1991-92 epidemic and 1977 epidemic also. That shows we have not been able to achieve elimination by taking district by district approach and we need to change this to village by village approach.

Durg availability: We decided to use amphotericin B (Fungizone) only for treatment, we assured that patients got treatment without any delay. Miltefosine was decided by the government to be used in seven districts. The supply of the drug became erratic and the whole programme became disturbed. The government used sodium antimony gluconate (SAG) largely in place of Miltefosine. The cure rate with SAG was low in Bihar and in some areas it was not effective (Lira et al., 1999; Sundar et al., 2000; Thakur, 1993) and there was some sperts of PKDL cases (table 1) in those areas (Thakur et al., 2008; Samiran et al., 2007). Fortunately we did not see any case of PKDL in our series of treated cases. PKDL is an important component of kala-azar elimination. For elimination of kala-azar there should not be any short supply of effective drug.

It was concluded that kala-azar could be eliminated without or with insecticide if there is an early detection of cases by camp approach in each village, shifting of all cases to distant places i.e. government hospitals, medical college hospitals government or private and even to CHC hospitals and block hospitals and treating those patients with an effective drug like amphotericin B (fungizone). The supply of medicine should be assured in all the places of treatment. The village should be an unit of elimination not the district. The heavily affected districts should be taken up first. This disease could be eliminated by 2015 provided there is a will and determination of the governments to do it.

The infrastructure and man power are sufficient to meet this challenge and this approach is feasible.

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