EPIDEMIOLOGICAL SURVEILLANCE OF FILARIASIS AFTER ITS CONTROL IN SHANDONG PROVINCE, CHINA

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Abstract. Shandong Province used to be the highly endemic area of *Wuchereria bancrofti*. *Culex pipiens pallens* was the main mosquito vector. After about 30 years of large scale anti-filariasis control campaign, filariasis was controlled throughout the province in 1983. Since then, extensive cross-sectional and consecutive longtitudinal surveillances have been carried out. Parasitological and entomological data indicated that the microfilaremia rate of the human population, and the natural infection rate of mosquito vector kept declining, with many villages dropping to zero; no children under ten were infected. Serological surveillance showed that antifilarial antibody had fallen to the same level as that in non-endemic areas 10-15 years after control. In addition, patients with chronic manifestations were reduced in number. It is suggested that the achievenment in filariasis control in Shandong Province is stable: the transmission of filariasis has been interrupted. However, there are still a few residual microfilaremia cases, which may bring about new infection under conditions favorable for transmission. Infectious sources may be introduced by population movements from a neighboring province where filariasis is still endemic at present. Moreover, new cases with chronic manifestations, especially chyluria, continually emerge. So systematic surveillance should be continued and proper control measures must be taken to eventually wipe the disease out of the province.

INTRODUCTION

Lymphatic falariasis has been one of the most important public health problems in Shandong Province, China. Since the foundation of People's Republic of China in 1949, epidemiological surveys had been carried out in the total of 106 counties and cities. In 74 counties/cities the prevalence of filariasis was due to *Wuchereria bancrofti,* which was mainly distributed in southwestern part of the province. According to the surveys made in 1957, the average microfilaremia rate (MFR) was 7.1%, with the highest being 26%. It was estimated that there were about 2.5 million microfilaremia cases and an equal number of patients with various clinical manifestations. *Culex pippiens pallens* was the main vector, and this species made up approximately 95% of the total mosquito population in human dwellings. The natural infection rate (NIR) of the mosquito vector was as high as 37.5%-51.9%. Of the infected mosquitos, up to 50% were found to be harboring infective larvae (Shandong Institute of Parasitic Diseases, 1983).

As early as 1958 when the control project of filariasis was incorporated into a national program, the provincial control campaign was initiated. Then in 1970, a large scale anti-filariasis campaign was carried out in endemic areas. Integrated intervention measures were adopted, which took elimination of the infectious source as the main objective. Generally three control measures were employed : repeated blood examination and selective treatment with diethylcarbamazine (DEC), repeated blood examination followed by DEC mass treatment of the whole population above five years old, and repeated blood survey and selective treatment followed by DEC medicated salt distribution to the total population. Through about 30 years effort, after assessment by the Ministry of Public Health, the province was the first one in China to reach the offical criterion of basic elimination of filariasis in 1983, namely the MFR of the population in every village dropped to below 1% (Cui *et al,* 1984).

Since the disease was controlled, extensive surveillance has been conducted to monitor the dynamics of transmission, to understand the alteration of chronic manifestations, and to predict the trend of prevalence, thereby to provide a scientific basis for strategy modification and also to offer experience to other provinces.

MATERIALS AND METHODS

Parasitological surveillance

Blood was taken from earlobe at night (from

21:00 to 2:00), made into two smears (each containing 60 mm^2), hemolyzed, stained and then examined under a microscope for microfilaria (Mf) (Cui *et al,* 1989).

Entomological surveillance

Mosquitos were captured from June to October every year house by house at the longitudinal surveillance spots. After identification of species, individual dissection was performed to detect the filarial larvae in *Culex pipiens pallens.*

Serological surveillance

Indirect fluorescent antibody test (IFAT) using frozen sections of *Brugia malayi* adult worm as antigen (Gao *et al,* 1990) or ELISA using soluble antigen of *B. malayi* adults (Gao *et al,* 1992) were employed to detect antifilarial antibody.

Survey of patients with chronic manifestations

In the areas where filariasis had been controlled more than 8 years before, cross-sectional surveys of patients with clinical manifestations were carried out (Cui *et al,* 1990).

RESULTS

Cross-sectional surveillance

1. Sampling survey: On the basis of the principle of stratified cluster random sampling, samples were selected in different directions and according to different control measures used previously. All the persons above one year old in the selected villages were investigated. From 1984 to 1991, a total of 466,090 person-times were examined by blood smear, and 147 were found positive for MF, with an average MFR of 0.03% (Table 1).

2. Parasitological investigation of focal population: 20,114 former microfilaremia cases were re-examined during 1984-1991: 9 were still found to be positive, the MFR being 0.04%. When the microfilaremia cases were interviewed, it was found that 6 of them had never received effective whole course treatment with DEC or had never taken sufficient DEC-medicated salt: and the other three were resurgent cases.

In order to find out whether the mobile population would introduce infectious sources, blood examination was given to 9,191 people coming from filariasis endemic areas of other provinces; 94 were found to be carrying microfilaria, with a MFR of 1.02% (Zhong *et al,* 1989; Li *et al,* 1991).

From 1984 to 1991, 54,662 children born after control of filariasis in different areas were examined None of them was found to be positive for Mf.

Longitudinal surveillance

During 1984-1988, 18 villages of 5 countries which were formerly hypo- or meso-endemic areas were selected as surveillance spots. A total of 15,715 persons above one year old were examined every year. The MFRs were 0.17%, 0.13%, 0.15%, 0.05% and 0.05%, respectively, and the average Mf density of positive cases dropped from 14.3 to 11.3 Mf/120 mm^2 blood. As to the 18 villages observed, 4 had not had any microfilaremia cases since 1984. In 7 villages, the MFRs fell from 0.08-0.36% in 1984 to zero in 1988; while in the other 4 villages, the MFRs dropped by 74.1%, 75.3% 80.0% and 83.1%, respectively in the 5 year periods; only in 3 villages were the MFRs still significant (0.07%, 0.09%, and 0.29%). No new microfilaremia cases occurred in any of the villages.

Table 1

Results of cross-sectional survey of filariasis during 1984-1991.

Year	No. of counties	No. of villages	No examined	Positive	
				No.	Rate(%)
1984	18	127	95,643	60	0.06
1985	30	184	135,220	52	0.04
1986	19	164	124,680	24	0.02
1987	8	66	47,778	2	0.004
1988	3	18	17,687	1	0.006
1989	8	24	5,340	0	0
1990	12	64	32,448	0	0
1991	2	5	7,294	0	0

From 1989 to 1991, other three surveillance spots besides the original 5 were chosen. Altogether 25 villages in 8 counties were monitored. The MFRs in the three years were 0.11%, 0.02% and 0.03%, respectively (Anonymous, 1991). All the microfilaremia cases were residual cases.

Entomological surveillance

From 1984 to 1991, 387,773 mosquitos were dissected, and 208 were found to be positive for filarial larvae, with the average natural infection rate being 5.4/10,000 (Table 2). Among the infected mosquitos, only three contained infective larvae. The infected mosquitos were all captured in the houses of microfilaremia cases or nearby.

In addition, 7,685 *Culex pipiens pallens* were captured in the mosquito nets of 173 person-time microfilaremia cases. 212 were positive for filarial larvae, the positive rate being 2.76% and no infective larva was found.

Serological surveillance

Observations on the change in population antibody level in various controlled areas were made. A total of 3,882 blood samples was collected and tested by IFAT. The results showed that the antibody level in the local population kept on declining year by year after the control of filariasis, and 10-15 years later dropped to the same as that in non-endemic areas. We observed that 96, 93 and 109 former microfilaremia cases, had become negative for Mf 8, 15 and 24 years earlier, respectively. The IFAT positive rates were 13.5%, 6.4% and 3.7%, respectively (Gao *et al*, 1990). In addition 948 children born after control of filariasis were examined by IFAT. Only 6 showed a positive reaction, with the positive rate of 0.63% (Anonymous, 1991).

Table 2

Results of mosquito vector surveillance of filariasis.

Year	No. of villages examined	No. of mosquitos dissected	No. of positive mosquitos	Average NIR (per 10,000)
1984	18	83,156	109	13.1
1985	18	71,170	38	5.3
1986	18	86,666	5	0.6
1987	18	27,983	2	0.7
1988	18	16,459	0	0
1989	25	57,631	34	5.9
1990	25	23,646	0	0
1991	25	21,602	3	1.4

In a longitudinal surveillance spot, ELISA was employed 7, 13 and 16 years after control of filariasis. The positive rates for anti-filarial antibody were 18.4%, 17.1% and 5.8%, indicating a tendency to decline (Gao *et al*, 1992).

Survey of patients with clinical manifestations

A population of 166,776 in 252 villages of former highly endemic areas was investigated. 1,038 patients were discovered, with an average morbidity of 0.6%. Among them, 383 had lymphedema/elephantiasis, 357 had chyluria and 298 had hydrocele. After control of microfilaremia, only a few lymphedema/elephantiasis and hydrocele cases emerged, accounting for 6.3% and 6.8% of total patients found, respectively. But chyluria cases continue to be found, 35.0%-50.2% of chyluria cases were being newly occurring after control of filariasis (Cui *et al*, 1990; Wang *et al*, 1990; Chen *et al*, 1988).

DISCUSSION

According to the results of surveillance, the MFRs of different controlled areas were far lower than 1%. Very few former microfilaremia cases remain positive for Mf. No children born after control of filariasis were infected. In addition, although there were still a lot of patients with clinical manifestations, the morbidity of clinical filariasis declined. The results demonstrate that the anti-filariasis campaign performed in Shandong Province has been successful; the criterion for control of filariasis drawn by Ministry of Public Health, China is dependable and the social benefit is apparent.

The parasitological and entomological surveillance indicates that in the surveillance spots, except in few villages, the MFR and natural infection rate of the mosquito vector kept declining without resurgence with many villages decreasing to zero. Only in a few villages which contained residual microfilaremia cases with high density of Mf were infected mosquitos detected. The results of serological surveillance showed that the anti-filarial antibody positive rate in the human population was also reduced year by year; in the area where filariasis had been controlled 10-15 years before, it fell to the same level as that in non-endemic areas. The data indicated that the transmission of filariasis has been interrupted.

Although a lot of work on surveillance of filariasis has been done in Shandong and an optimistic perspective can be predicted according to the data, there still remain some problems. In some areas of the province, a few microfilaremia cases and infected mosquitos could still be found (Cui *et al*, 1989; Zhong *et al*, 1989). Although field and laboratory studies have suggested that in endemic areas of Bancroftian filariasis with *Culex pipiens pallens* as the vector, when the MFR of the human population in a village dropped to below 1% and the average density of Mf fell to around 5Mf/60mm^2, the residual microfilaremia cases can become negative within 3-5 years and thus they have no epidemiological significance (Shi *et al*, 1988). Furthermore, in many rural areas, breeding sites of mosquito vectors remain as they were and facilities for mosquito prevention have never been radically improved. So the role of residual microfilaremia cases, especially these with medium and high density of Mf, in the transmission of filariasis should not be ignored. Bancroftian filariasis is still endemic in a neighboring province, and population movement has been increasing. Imported sources of infection have been found in the controlled areas. In the latter areas, the incidence of filarial lymphedema/elephantiasis and hydrocele have been reduced, but new cases with chyluria continually emerge. Meanwhile, up to now there have been no effective treatment methods for lymphedema/elephantiasis and chyluria other than surgery. So systematic surveil-lance should be continued, and patients with chronic manifestations need to be treated properly to reach the ultimate target of filariasis eradication.

At present, the MFR has dropped to extremely low level. Under these circumstances, the traditional method of identification by blood examination has been obviously unsuitable for detection of infectious sources. According to the data, mosquito vectors captured in the houses of microfilaremia patients were found to be positive for filarial larvae. So it is necessary to develop sensitive approaches to identification of filarial larvae in mosquito vectors to search for infectious sources. Although the dissection of mosquito vectors followed by visual identification and counting of parasite larvae is widely used to monitor filariasis control programs, this method is not ideal since it requires morphologically intact specimens and is time-consuming. In the absence of substantial financial influx for the surveillance of filariasis at the post-control stage, it is suggested that a priority is to develop a method which can process and analyze large batches of crudely preserved specimens. For example, DNA probes for identification of filarial larvae in the vector can meet the requirement.

Immunodiagnostic techniques should also be further developed and improved to seek sensitive, specific, cost-effective and practical alternatives to the present routine nocturnal blood smear check in filariasis surveillance. Immunological surveillance should prove to be especially useful when the disease has been controlled and it is difficult to obtain blood samples at night for detection of Mf.

Vector control is one of the most important links to consolidate the achievements in filariasis control. The improvement and management of environmental conditions should be strengthened. In addition, personal protection from bites of vector mosquitos is a practical form of prevention against filariasis infection. The use of mosquito nets at night and the use of screened windows should also be encouraged.

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