

# THE CONTROL AND SURVEILLANCE OF FILARIASIS IN HAINAN PROVINCE, CHINA

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**Abstract.** Hainan is a single bancroftian filariasis endemic province where filariasis is prevalent in all 18 cities and counties. A program to control filariasis was started in 1953. The strategy of eliminating infection sources has been adopted as the principal intervention measure in filariasis control. Over 30 years, the sustained effort throughout the province reached the point of basic elimination of filariasis in 1987. After the basic elimination of filariasis, the patterns of filariasis transmission in residual microfilaremia cases in Hainan Province were studied so as to provide a scientific basis for formulating strategies to eliminate filariasis. According to the "Technical scheme for surveillance in areas where filariasis has been basically eliminated" issued by the Ministry of Health, a longitudinal and cross-sectional and entomological surveillance of filariasis was carried out using parasitological and entomological and serological methods in the whole province during 1983-2004. In the cross-sectional and entomological surveillances, the last microfilaremia case was found in 1999, no mosquitoes were found to be infected with filarial larvae. A total of 132 microfilaremia cases found in the longitudinal surveillance become negative by 10 years. Since 1997 no mosquitoes were found to be infected with filarial larvae in the longitudinal surveillance. Serological surveillance of the population showed the mean positive rate of IFAT dropped from 10.63% in 1990 to 0.28% in 2000, which being similar to that of nonendemic areas. The results show that residual sources of infection after basic elimination of filariasis were tending to be naturally eliminated and transmission of filariasis has been interrupted in Hainan Province.

## INTRODUCTION

Hainan Province located in southern China, 18°10' to 20°10'N latitude and 108°37' to 111°03' E longitude, is a tropical zone where the climate is warm and the mosquito vectors are active all year round which is quite suitable for the transmission of filariasis. Hainan Province mainly consists of Hainan Island, including 18 cities and counties, Xisha archipelago, Zhongsha archipelago and Nansha archipelago, with a population of 8.28 million. Hainan is a single *Wuchereria bancroftian* filariasis en-

demic province where filariasis is prevalent in all 18 cities and counties. The principal transmission vector is *Culex quinquefasciatus*. It is estimated the total number of filariasis cases were 0.36 million according to massive surveys of filariasis since 1950s. The control of filariasis started in 1953 (Wu *et al*, 1990) and was divided into three phases: massive surveys of filariasis and preparation (1953-1971), pilot control trial (1972-1979) and massive control (1977-1986). Through 30 years of sustained effort the whole province reached a state of basic elimination of filariasis in 1987 (the microfilaria rate decreased to less than 1% in the endemic villages of the province after the control program). After basic elimination of filariasis, all control measures were stopped and

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surveillance was initiated, through a systematic surveillance of more than ten years when the goal of eliminating filariasis in Hainan Province was achieved in 2005.

## MATERIALS AND METHODS

### Control of filariasis

Treating the sources of infection was chosen as a major control measure. Other addition, the measures, such as pesticide spraying, use of insecticide-impregnated bednets, and environmental modification were adopted in filariasis-endemic areas, in combination with patriotic health campaigns and malaria control activities. The method of treating the source of infection was as follows.

**Diagnosis.** Thick blood smears are generally used in field work and in massive surveys. One hundred twenty microliters of blood was taken from the ear lobe between 9:00 PM and 2:00 AM, thick blood smears were performed on two slides and examined by microscopy after staining

**Treatment of patients.** All microfilaremias were treated with 2-3 or more standard courses of DEC (Diethylcarbamazine) tablets. The total dose for each course was 3.0-4.2 grams over 3-7 consecutive days. Patients who became smear negative after treatment were considered as cured.

DEC added salt prophylaxis was carried out depending on the infection rate in the inhabitants in the endemic area. Three doses of DEC added salt were given to the inhabitants. The DEC added salt in a ratio of 0.3% (3 grams DEC to 1,000 grams salt) was supplied to the inhabitants for daily use for 2-6 months. The daily intake of DEC approximated 50 mg.

### Surveillance of filariasis

**Cross-sectional surveillance.** Cross-sectional surveillance covered all filariasis endemic cities and counties along with the following requirements: 1) the number of parasitological

surveillance foci was over 30% of the total endemic towns or townships, and the sampled people in the blood survey were over 3% of the total endemic population in the county; a thick blood smear was used for the blood survey. 2) Mosquito vector surveillance covered at least 3 parasitological foci in the county. Households for mosquito catching was selected by random or systematic sampling method and the number of detecting samples of *Cx. quinquefasciatus* and *Cx. pallens* were at least 3,000. Mosquito dissection was used to detect filarial worms in mosquitoes. 3) Serological surveillance to test for the presence and titers of antifilarial antibodies by immunological tests, such as indirect fluorescent antibody test (IFAT) were used.

**Longitudinal surveillance.** A sampled village with a population of 1,000-2,000 persons was selected based on its endemicity, of which the microfilaremia rate in the population and microfilarial density in the positive cases were relatively high in the last survey. The parasitological surveillance, mosquito vector surveillance and serological surveillance were performed longitudinally in the sample village. For parasitological surveillance, tracing of blood tests and blood surveys were undertaken in the residual microfilaremia cases and residents, respectively. The microfilaremia cases were followed by establishment of a personal card without any antifilarial treatment, and blood tests were taken every one or two years until negative on the test. The negatives were verified by follow-up tests at least three times. For all residents aged 1 year and over in the sampled village, blood was examined once every two years until the microfilaremia rate in the residents decreased to zero. The methods for parasitological surveillance, mosquito vector surveillance and serological surveillance were the same as described in cross-sectional surveillance.

### Surveillance of mobile population

Surveillance of the population was carried out by parasitological and serological detec-

tion to find microfilaremia cases in the population coming from an endemic area and living in a local area for at least six months. All microfilaremia cases were treated with the standard course of treatment.

## RESULTS

### Control of filariasis

During the period of filariasis control in Hainan Province, a total of 6,564,529 subjects were examined, 143,580 subjects were treated with DEC, 402,329 subjects were treated by mass drug administration, and 610,145 subjects were treated with DEC salt. Success was achieved in the filariasis control, and Dingan County first reached a state of

basic elimination of filariasis in 1979. Since then other counties and cities reached a state of basic elimination of filariasis. Finally the whole province reached a state of basic elimination of filariasis in 1987.

### Cross-sectional surveillance

**Parasitological surveillance.** Cross-sectional surveillance was conducted from 1983 to 2005 on a total of 310,149 people by blood examination; of these, 118 residual microfilaremia cases were found (Table 1). The coverage rates for endemic townships and endemic populations were 65.99% and 11.53%, respectively. The prevalence of infection decreased with time after basic filariasis elimination had been achieved. The last microfilaremia case was

Table 1  
The results of cross-sectional surveillance of filariasis in Hainan Province after basic elimination of filariasis.

Year	County no.	Township no.	No. Examined	No. with microfilaremia	Microfilaria rate (%)
1983	1	3	1,265	19	1.50
1984	4	4	5,148	6	0.12
1985	1	1	481	0	0.00
1986	9	9	5,809	15	0.26
1987	14	21	13,607	20	0.15
1988	1	1	935	0	0.00
1989	14	29	35,297	26	0.07
1990	15	26	40,344	12	0.03
1991	14	18	24,201	7	0.03
1992	10	15	18,251	2	0.01
1993	12	14	17,820	0	0.00
1994	11	14	20,221	0	0.00
1995	13	15	20,226	0	0.00
1996	12	15	15,147	0	0.00
1997	10	12	13,761	0	0.00
1998	11	11	16,145	2	0.01
1999	10	11	15,094	9	0.06
2000	12	15	14,816	0	0.00
2001	8	15	15,954	0	0.00
2002	5	9	10,436	0	0.00
2003	3	5	5,191	0	0.00
Total		263	310,149	118	0.04

Table 2  
Results of serological (IFAT) surveillance of filariasis in Hainan Province.

Year	County no.	Town no.	No. of persons examined	No. of positive cases	Positivity rate (%)
1990	1	1	527	56	10.63
1991	2	2	835	76	9.10
1992	2	2	621	46	7.41
1993	1	1	368	12	3.26
1994	2	2	675	39	5.78
1995	2	2	691	15	2.17
1996	1	1	275	9	3.27
1997	2	3	888	22	2.48
1999	1	1	322	4	1.24
2000	1	1	352	1	0.28
Total	15	16	5,554	280	5.04

found in Qiongsan County in 1999.

**Serological surveillance.** A total of 5,554 people were tested in this province during 1990-2000, of which, 280 (5.04%) were antibody-positive. The prevalence and level of antifilarial antibodies decreased with time in the later stage of surveillance after basic elimination (Table 2).

**Mosquito vector surveillance.** From 1992 to 2004, a total of 465,071 mosquitoes were dissected in cross-sectional surveillance in the province. No mosquitoes were found to be infected with filarial larvae.

#### Longitudinal surveillance

From 1982 to 1999, a total of 4 longitudinal surveillance sites were established in the province. Of the 4 surveillance sites selected, 2 conducted long-term observations, and no new chronic filariasis cases emerged. The results show that residual microfilaremia cases turned to negative gradually over 10 years. The longest interval before microfilaria clearance was 9 years in one individual. Microfilaria rates decreased year by year in all longitudinal surveillance sites. No new infected cases were found, and filarial larva infection rates of mosquitoes also decreased gradu-

ally. No infected mosquitoes have been found since 1997.

#### Mobile population surveillance

From 1989 to 2000, mobile population surveillance has taken place in the province. Of 13,743 people who came from filariasis endemic areas in other provinces, 6 were microfilaria-positive. All these infections were detected before 1992. There have been no microfilaremia cases since 1993.

## DISCUSSION

Hainan Province is located in a tropical zone where the climate is warm and mosquito vectors are active all year round, suitable for the transmission of filariasis. Filariasis is not only an important public health problem, it has also contributed significantly to poverty and inhibited economic development. During the early stages of control, comprehensive measures were taken for controlling filariasis in the province. After pilot studies showed the impact of reducing microfilaremia with DEC in the 1970s, considering the relative inefficiency of filariasis transmission and the availability of an effective and safe filaricide, diethylcarbamazine (DEC), in treating microfilaremia cases,

the strategy for eliminating infection sources has been adopted as the principal intervention measure in the filariasis control program. Based on considerable research from pilot studies, three DEC treatment schemes were elucidated for filariasis control: mass screening and selective treatment with DEC tablets, mass treatment with DEC tablets, and mass treatment with DEC salts. Due to its feasibility, safety, effectiveness, and low frequency of adverse reactions, use of DEC salts avoided several logistical and programmatic challenges (Ru *et al*, 1984) including the need for mass blood examinations at night and unacceptable adverse reactions to DEC tablets, which led to treatment non-compliance. Thus, widespread use of DEC accelerated the process of filariasis control in Hainan Province.

*W. bancrofti* exhibits strict nocturnal periodicity, therefore, large-scale screening has had to be conducted late at night, a situation never encountered in the control of any other disease. In addition, most microfilaremia cases, as sources of infection did not have typical clinical manifestations. Side effects have been noted, such as fever and inflammation of lymphatic vessels after taking DEC treatment. This makes treating microfilaremia cases with DEC challenging, requiring the understanding and support of the people. Thanks to the persistent guidance of the government, cooperation of relevant departments at all levels and full participation of the population, 6.56 million blood examinations, 0.14 million individual treatments with DEC, and widespread mass treatment has been accomplished successfully.

The study showed that filariasis transmission tended to be interrupted even without control measures when the microfilarial rate was below 1% and the microfilarial density less than 10 per 60  $\mu$ l of blood (Collaborating research group on the transmission threshold of filariasis, 1994). By quantitative dynamic analysis with the mathematic model, we found trans-

mission and epidemic velocity of filariasis is very low and its transmission potential is also very low, so it is possible to interrupt its transmission (Chen *et al*, 2003). This research indicates, after basic elimination of filariasis in an area, the microfilarial rate in the population was below 1% and the residual sources of infection dispersed. In consideration of cost, it is not necessary to carry out a massive blood survey to find the infection sources. Establishing sensitive cross-sectional and longitudinal surveillance systems to detect and clear residual sources of infection can achieve the objective of elimination of filariasis.

After basic elimination of filariasis in Hainan Province, a systematic surveillance was carried out for several years. The main tasks of surveillance were to detect and clear residual sources of infection, and provide evidence for filariasis elimination. The results of surveillance demonstrated there is no more microfilaremia or natural infection with filarial larva in humans or mosquito vectors as seen by transmission dynamics oriented longitudinal surveillance and cross-sectional surveillance. At the same time, a residual endemic spot was discovered in Tingfeng village of Qiongsan County during cross-sectional surveillance. Investigation of the residual endemic spot found that control measures had not been implemented in full. This suggests that weak points in the control can be discovered and strengthened promptly through effective surveillance (Ton *et al*, 2001).

In 2005, assessment and acceptance of the results of eliminating filariasis in this province were undertaken by the assessment and acceptance group consisting of members of the National Scientific Steering Group for Filariasis Control. It was confirmed that Hainan Province had reached the state criterion of elimination of filariasis. Hainan's successful experience has proved that even under the current economic and technical conditions, lymphatic filariasis, which endangers the

health of humankind and causes severe disability, can be controlled and eliminated in tropical areas when adequate and sustainable control measures are actively applied.

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