STUDY OF SIMPLIFIED MEASURES FOR MALARIA SURVEILLANCE IN THE LATE CONSOLIDATION PHASE IN CHINA

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Abstract. This paper presents the results of a study on simplified surveillance methods conducted in 23 pilot counties in 11 provinces and municipalities in China where reside 15 million people and malaria control has been in the late consolidation phase. Two simplified surveillance Schemes (A and B) taking treatment of clinical cases as the main measure were implemented in 1992-1994. The rate of annual blood examination for case detection was 1.0% in pilot Scheme A, while in areas of scheme B it was 0.3%. The implementation of both Scheme A and Scheme B, simplified or without treatment of infection foci and management of mobile populations, acquired satisfactory effects against malaria. Consequently, malaria incidence was declining steadily, only a few indigenous and introduced cases were detected. The parasite rate in residents and the IFA positive rate in children were very low. The results of pilot studies and cost-effectiveness analysis indicated that Scheme B is effective, rational and economic, and can be implemented to replace the routine surveillance measures in areas where malaria has been at the late consolidation phase in China.

INTRODUCTION

In China, the nationwide malaria control program was initiated in 1955 on the basis of primary health care networks and community participation. The control of malaria was implemented according to the principles of adopting integrated measures and repeated practices which were characterized by time- and locality-oriented approaches. The generally accepted concepts leading to the adoption of integrated antimalaria measures concentrated on measures which varied for areas of different vectorial ecology and endemicity. In endemic areas where *Anopheles sinensis* is the vector, integrated measures with emphasis on elimination of infection source and prevention of mosquito breeding are recommended, with reduction of mosquito breeding sites in villages. In endemic areas where the major vectors are *An. minimus* and *An. anthropophagus*, antimalaria measures are focused on mosquito vector control and elimination of the infection source. In endemic areas where the major vector is *An. dirus* the main measure is to change the ecological environment so as to reduce the mosquito population, and thus emphasize infection source control. In areas where the incidence has decreased to below 0.01%, malaria surveillance is justified as the predominant practice, which includes case detection, focus intervention, management of migrant populations as well as prompt incidence surveillance and vector monitoring (Department of Control of Endemic Diseases, 1988).

As a result of active implementation of malaria control measures for more than 40 years, many provinces have achieved very good progress in

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malaria control and effective surveillance of fever cases based on blood smear examination. Febrile patients are generally classified into 4 types according to clinical picture (clinically diagnosed malaria, suspected malaria, fever of unknown origin (FUO), suspected common cold) (Advisory Committee on Parasitic Diseases, 1992). At village level, presumptive treatment is commonly given, blood smears are sent to a county (or township) anti-epidemic station and examined microscopically, the results are sent back to the village doctor in several days, so that appropriate definitive treatment may be offered. This approach can result in considerable unnecessary administration of antimalarials, incomplete therapy, and a large number of negative slide examinations. On the positive side, the extensive and intensive nature of the program has undoubtedly protected many places of the country from disease transmission and epidemics. At the same time, it is clear that improvement of the strategy is urgently needed.

Seeing that most of the endemic areas where *An. sinensis* is the only vector are now in the late consolidation phase, the Ministry of Health formulated criteria to define this phase (*ie* malaria basically eliminated) namely: (1) malaria incidence of the county (or city) lower than 0.01% for three consecutive years; (2) blood smear examination with a coverage more than 90% of villages and the number of blood examinations accounting for 5% of the total population; (3) radical treatment of malaria cases and effective malaria surveillance; and (4) effective measures for vector control (Ministry of Health, 1988).

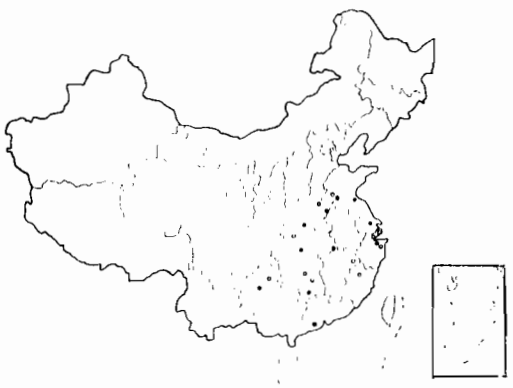
The need for revision of the malaria surveillance strategies, especially in areas affected by *An. sinensis* with low vectorial capacity was discussed at a national meeting on malaria situation in 1990. Supported by the Ministry of Health, the malaria advisory committee commissioned a task force involving staff from 11 provinces for evaluation of alternative strategies (Tang *et al*, 1991). The initial draft raised the following deliberations comprising improvement of surveillance approaches, reduction of blood slides to be examined, rational focal intervention and cost-effectiveness analysis. With this pattern of collaboration as a background, in 1992-1994 a study on simplified surveillance methods was conducted in 23 pilot counties of 11 provinces and municipalities where reside a total population of 15 million, malaria control is in the late consolidation phase and *An. sinensis* is the vector.

MATERIALS AND METHODS

A longitudinal study was pursued to compare the effects of two simplified schemes (A and B) in target population living in malarious areas.

Study areas

Twenty-two counties in 10 provinces were selected as pilot areas where *An. sinensis* is the only vector and the incidence of malaria was lower than 0.01% in the past three years; blood smear examination of fever cases was carried out as a routine surveillance measure, and the socio-economic conditions in peer-counties where different schemes were carried out are similar. Besides 22 pilot counties, Taishan county in Guangdong Province with *An. minimus* as the major vector was selected for evaluation of the effects of different surveillance schemes on different vectors (Fig 1).



● Scheme A
o Scheme B

Fig 1–Distribution of 23 pilot counties for performance of simplified surveillance measures.

Surveillance methods

Two simplified Schemes (A and B), involving the deletion of some practices of routine malaria surveillance measures were designed and implemented (Table 1).

Table 1

Malaria surveillance schemes.

Measures	Routine scheme	Scheme A	Scheme B
Case detection	Blood smear exam 4 sorts of febrile cases;[1] ABER 5% –	Blood smear exam 3 sorts of febrile cases;[2] ABER 1% Encourage microscopists to detect positive cases.	Blood smear exam 2 sorts of febrile cases;[3] ABER 0.3% Encourage microscopists to detect positive cases.
Focus intervention	Case treatment; All residents in active foci treated; Insecticide spraying in active foci sites.	Case treatment; Family members of malaria case treated; All residents in village treated when occurring 2 or more cases within a month in a focus site.	Case treatment; – –
Management on mobile population	Blood examining on all febrile cases; Prophylaxis in target population from hyperendemic areas; or insecticide residual spraying.	Blood examinng on 4 sorts of febrile cases; Prophylaxis in target population from hyperendemic areas; or treatment on parasite positive cases.	Blood examining on 4 sorts of febrile cases; –

[1] Clinically diagnosed malaria, suspected malaria, fever of unknown origin and suspected common cold.
[2] Clinically diagnosed malaria, suspected malaria and fever of unknown origin.
[3] Clinically diagnosed malaria and suspected malaria.
ABER = Annual blood examination rate.

Scheme A was performed in 12 counties and cities with 8.577 million population, and Scheme B, in 11 counties and cities with 6.164 million population.

Case detection: Passive detection of cases in clinics, hospitals and health centers was implemented. For Scheme A, blood examination was performed on 3 classes of febrile patients, *ie* clinically diagnosed malaria, suspected malaria and FUO, the annual blood examination rate (ABER) was planned to be no less than 1% of the total population. For Scheme B, blood examination was performed on 2 classes of febrile patients, *ie* clinically diagnosed malaria and suspected malaria cases; ABER was planned to be no less than 0.3%. In all the above pilot sites, antimalarial treatment was given to parasite positive cases.

Focus intervention: In pilot areas of Scheme A, family members of the indigenous or introduced malaria cases were treated with antimalrials; when 2 or more indigenous cases occurred at a focal site within one month, the whole village or neighboring households would also be treated. In pilot areas of Scheme B, no such focus treatment was undertaken.

Malaria management in mobile population: In areas of Scheme B, management and surveillance of the mobile population only relied on blood examination of 4 classes of febrile patients and treatment of parasite detected cases. In areas of Scheme A, besides the measures mentioned above, prophylaxis was given to groups of mobile people from hyperendemic areas and antimalarials were administered to the parasite positive cases.

Implementation methods

During 1992-1994, Schemes A and B were carried out as follows: malaria cases were calculated

according to blood examination; each case was investigated and followed up, and sorting of cases was done, taking one natural village as a unit to count the number of categorized malaria foci. In each pilot county, villages were selected for survey of parasite rate in inhabitants and positive rate of IFAT in children. The ratio between introduced cases and imported cases was calculated as the malaria transmission index. *U* test and X^2 test were used for analysis of the difference in the malaria incidences, distribution of foci and malaria transmission indices between the two areas of the Schemes A and B.

The expenditure for implementing the malaria surveillance scheme was recorded for cost-effectiveness analysis. The direct cost included expenditure on salaries of microscopists and administration staff involved in the disease surveillance, on reagents, materials and equipment for blood examination, on antimalarial drugs, on travel, communication and table form, etc. Indirect costs included expenditure on travel, a commodation borne by the patients and their families. Considering the currency inflation in the implementation phase, compound interest of 12% according to the official estimation was counted. The unit cost per slide examined and per treatment were calculated, respectively. For evaluating the effectiveness of the malaria surveillance scheme overall, an index system, entitled the Malaria Surveillance Effectiveness Index (MSEI), was built up using the Delphi method. MSEI included three indices, *ie* autochthonous incidence, ratio of cases detected (ROCD), and ratio between introduced cases and imported cases. The formula:

$$MSEI = \sum_{i=1}^{n} X_i \times W_i$$

n: number of indices

i: identified index

X_i: percentage of the increase or decrease of identified index

W_i: weighting of identified index

The cost/MSEI was used to determine which scheme had greater cost-effectiveness.

RESULTS

Blood examination rate and positive parasite rate

During 1992-1994, in areas where Scheme A was implemented, 325,499 local residents with fever experienced blood examination, the average blood examination rate being 1.25%. Two hundred and seventy-four cases were positive for *P. vivax*, and 2 cases of *P. falciparum* were detected from returned people, the overall positive rate was 0.085%. There were 66,960 local febrile residents who were blood-examined in areas of Scheme B, the average blood examination rate being 0.36%. Among them, 421 cases were positive for *P. vivax*, the positive rate being 0.628%, which was significantly higher than that of the areas of Scheme A ($p < 0.01$). During the three years, of 420,198 blood slides subjected to microscopic examination, 1,043 were detected as positive, the average positive rate being 0.25%. For the febrile patients in the categories of clinical malaria and suspected malaria, the average positive rate was 7.13% (963/13,512), representing 92.3% (963/1,043) of the total positive cases noted. The average blood examination rate of the above 2 types of febrile cases and FUO, was 0.32% (1,039/324,114), accounting for 99.6% (1,039/1,043) of the total positive cases (Table 2).

Incidence of malaria

In areas of Scheme A, malaria occurred in 276 local residents, the average annual incidence being 0.00106%, of which the exogenous and autochthonous cases were 0.00071% and 0.00035%, respectively. In areas of Scheme B, malaria occurred in 421 in local residents, the average annual incidence of malaria being 0.00229%; among which, exogenous and autochthonous cases were 0.00196% and 0.00033%, respectively (Table 3). There was no significant difference in malaria incidence in the residents without migration history in areas of the different schemes ($p > 0.5$). Furthermore, the incidence among local residents in areas of Schemes A and B was 0.00033% and 0.00028%, respectively; when compared to that of the year 1991 (0.00067% and 0.00052%), before the performance of the simplified surveillance methods, a decline of 50.7% and 46.2%, respectively was recorded.

Table 2

Positive rates of blood examination in different sorts of febrile patients.

Clinical diagnosis	No. persons examined	No. positive	Positive rate (%)	Positive cases detected/total positive cases
Typical malaria	1,039	670	64.49	64.24
Suspected malaria	12,473	293	2.35	28.09
Fever of unknown origin	310,602	76	0.02	7.29
Suspected common cold	96,084	4	0.004	0.38

Table 3

Malaria incidence in local residents in 1992-1994.

Scheme	Total population in three years (ten thousand)	Exogenous cases		Autochthonous cases	
		No. cases	%	No. cases	%
A	2,613.7	185	0.00071	91	0.00035
B	1,836.8	360	0.00196	61	0.00033

Type of focal sites and treatment

During the 3-year study, in areas of Scheme A, 463 focal sites were found, of which 95 were active sites where malaria transmission still occurred, and 368 were inactive sites, the ratio of active to inactive focal sites being 1:3.87; in areas of Scheme B, 381 focal sites were found, of which, 34 were active sites and 347 were inactive ones (= 1:10.2). The results indicated that most of the focal sites in the study areas were inactive in malaria transmission, where only a few malaria cases occurred, imported ones being predominant (Table 4).

Taishan county was one of the pilot areas of Guangdong Province with *An. minimus* as the major vector. In 1992-1994, Nineteen introduced cases of malaria were detected which accounted for 10.38% of the imported cases; whereas in study areas with *An. sinensis* as the only vector, for Scheme A and

Table 4

Classification of malaria focal sites malaria in study areas.

Scheme	No. focal sites	Residual		New	
		Inactive focal sites	Active focal sites	Inactive focal sites	Active focal sites
A	463	14	14	354	81
B	381	14	11	333	23
Total	844	28	25	687	104

Scheme B, the ratios of introduced to imported cases were 0.68% (2/292) and 1.44% (6/416), respectively, demonstrating that there was a significant difference ($p < 0.01$) in contribution of imported cases to local malaria transmission in areas affected by different vectors. But in areas where *An. sinensis* was the only vector, no matter whether Scheme A or Scheme B was implemented, introduced cases from imported sources were very few; there was no significant difference ($p > 0.5$).

Parasite rate and positive rate of IFA

A total of 13,145 local residents without migration history in the areas of Scheme A were randomly selected for blood examination. Two persons positive for *P. vivax* were found, the parasite rate being 0.02%. There were 27,238 pupils tested by IFA, the positive rate (titer > 1:20) being 0.48%. Altogether the blood smears of 6,119 local residents without migration history in the areas of Scheme B implemented were examined, no positive case was detected. The results of IFA performed on 25,989 pupils showed a positive rate of 0.36%.

Cost analysis of Schemes A and B

The data based on investigation and checklists in pilot areas as well as the records from 23 counties were analyzed and calculated. The cost analysis illustrated that the total expenditure for case detection and focus treatment was markedly higher by implementing Scheme A than by Scheme B over 3 years, namely 412,513.4 yuan and 93,444.8 yuan, for Schemes A and B, respectively, an average of 0.018 and 0.005 yuan per person per year, respectively. The unit cost per slide examined was RMB 1.39 yuan. The cost of picking out a positive case was RMB 433.6 yuan and 19.5 yuan, respectively for Scheme A and Scheme B, a difference of 22.2 times. In a county with an average population of 600,000, the annual costs of case detection and focus treatment were RMB 10,800 yuan and 3,000 yuan, for Scheme A and Scheme B, respectively. The Malaria Surveillance Effectiveness Index (MSEI) was 48.56 and 45.93 for Scheme A and Scheme B, respectively (Table 5). The total cost/MSEI as the integrated index was 8494.92 and 2034.51, for Scheme A and Scheme B, respectively, *ie* heightening 1% ROCD requires the additional cost of RMB 59,223.1 yuan, equal to 4 times that of Scheme B (Tabke 6).

DISCUSSION

The results of studies on simplified malaria surveillance methods conducted in 23 pilot counties with a total population of 15 million in 11 provinces and municipalities where malaria has been in the late consolidation phase indicated that both Scheme A and Scheme B, simplified, or without treatment of infection foci and management of mobile populations, gave effective malaria control, *ie* malaria incidence declined steadily and few indigenous and introduced cases occurred. The average malaria incidence in local residents of the study areas of Schemes A and B implemented during the 3 years was 0.00035% and 0.00033%, respectively. No significant difference existed. The incidence in the third year (1994) in areas of Schemes A and B decreased by 50.7% and 46.2%, as compared with that of 1991 before the study. Most of the 1,043 malaria cases detected were imported ones, which indicated that areas with *An. sinensis* as the only vector were in the late consolidation phase, that the surveillance methods can be simplified and that Scheme B as an effective and inexpensive measure can be implemented to replace the previous routine surveillance measures in China.

Case detection is the major component of malaria surveillance in endemic areas where new and rapid diagnostic methods are unavailable for routine use, so that blood smear examination of febrile patients is still the principal way to detect patients. Since the 1980s, persons with any one of the "four sorts of fever" (clinically diagnosed malaria, suspected malaria, FUO and suspected common cold) have been conventionally subjected to blood examination (Tang *et al*, 1995). Nevertheless, in that study, it was noted that the positive cases detected from "two sorts of fever" accounted for 85% of the total positive cases (Anonymous, 1988; Yang *et al*, 1991; Anonymous, 1984; Jiangsu Institute of Parasitic Diseases, 1983). However, in areas of low transmission, clinical manifestations of malaria cases become more apparent owing to the decline of population immunity, so that it is possible to reduce the number of blood smear examinations. According to the results of our study,clinically diagnosed malaria cases and suspected malaria cases accounted for 92.3% of the total positive cases at the first time of seeking medical help, while the remaining positive cases (7.7%) undetected the first time could be mostly detected on the second on occasion of seek-

Table 5

Malaria surveillance effectiveness index.

Effectiveness index (i)	Weighing (W_i)	Scheme A				Scheme B			
		Before implement	After implement	Decrease % (X_i)	Score (MSE_i)	Before implement	After implement	Decrease % (X_i)	Score (MSE_i)
Autochthonous incidence (0.01%)	0.36	0.076	0.026	65.79	23.68	0.052	0.028	46.15	16.61
Ratio of case missing detected	0.031	-	-	0.38	-0.12	-	-	7.67	-2.38
Ratio of introduced cases to imported cases	0.33	8/206	1/106	75.77	25.00	20/129	1/165	96.06	31.70
Total	1.00				48.56				45.93

Table 6

Cost-effectiveness analysis of Scheme A and Scheme B.

Scheme	Cost (yuan)	MSEI	Cost/MSEI
A	412,513.44	48.56	8,494.92
B	93,444.82	45.93	2,034.51

ing medical help when symptoms became typical. If the subjects for blood smear examined are "three sorts of fever" (the first 2 sorts plus FUO), the detected cases accounted for 99.5% of the total positive, but the number of blood smear examinations and the average cost for detecting a positive case increased more than 20 times. Based on epidemiological evidence and results of the pilot study, we suggest that in areas at the late consolidation phase with *An. sinensis* as the only vector, the local residents with either of the "two sorts of fever" be subjected to blood examination, while for the mobile population, "three sorts of febrile" patients should be included in blood examination where there is likely to be a higher positive rate in the population. An annual blood examination rate of 0.3% is recommended for the study areas. For implementation, Scheme B is more cost-effective than Scheme A. Using Scheme B, the blood examination scale and number can be reduced, the majority of malaria cases can be detected, and malaria control can still be kept at the consolidation status, but at the same time, saving considerable manpower, material resources and expenditure.

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