RESEARCH NOTE

PYRETHROID INSECTICIDE TREATED BEDNETS FOR MALARIA CONTROL IN THE PEOPLE'S REPUBLIC OF CHINA

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The use of bednet and curtains treated with pyrethroid insecticides, such as permethrin, deltamethrin, lambdacyhalothrin and alphamethrin for malaria and control of its vectors is considered to be one of the most promising advances in malaria control in past 40 years (Rozendaal and Curtis, 1989). It has been much more extensively field trialed and used in China than anywhere else (Table 1) and it is suggested that treated bednets for malaria control seem much more effective in China. This note analyses the biological and socio-economic reasons underlying the Chinese situation.

Table 1

Coverage of pyrethrin insecticide treated bednet in China, 1986-1995.

Year	Population in millions
1986	0.31
1987	2.63
1988	5.36
1989	4.53
1990	5.13
1991	5.45
1992	4.40
1993	5.32
1994	4.38
1995	3.98

Bednets treated with pyrethroid insecticides could theoretically reduce malaria transmission in two ways: by decreasing a mosquito population as a whole by increasing mosquitos mortality; and by providing protection to individuals sleeping under treated bednets (or in houses with treated bednets). The killing of mosquitos coming to bite may be a crucial benefit for a whole community. But a noticeable reduction in mosquito population density needs widespread use of treated bednets (Li *et al*, 1989; Luo *et al*, 1994a; Cheng *et al*, 1995). The longevity and hence the vectorial capacity and sporozoite rate of the local mosquito population can be expected to be reduced with large scale bednet treatment. Such a large scale bednet treatment would be important as indirect protection not only for people without nets, but also for anyone sitting outside in the evening before going to bed. However, if treated nets are more effective in repelling than killing mosquitos, unprotected people might suffer a higher risk of infection with malaria. Furthermore, if only a small percentage of the whole community is protected by treated bednets, mosquitos might be diverted to unprotected people, who would then be at a higher risk of infection with malaria. In China, all the trials have been on a large scale. The percentage of treated bednets in the community was very high, with at least 85% of the total population in the community covered by treated bednets. In most high malaria endemic areas of China, there are two main malaria vectors, *An. anthropophagus*, an endophilic, and anthropophilic mosquito, and *A. sinensis*, an exophilic and zoophilic mosquito. *An. anthropophagus* has a greater preference for human blood and is easily killed by contact with treated bednets. *An. sinensis* prefers cattle or other animals. Mass use of treated bednets greatly decreased the population of *An. anthropophagus*, approximately to zero in some areas (Li *et al*, 1989; Luo *et al*, 1994 a, b, c; Cheng *et al*, 1995). The treated bednets had less effect on

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the population density of *An. sinensis*. But people were none-theless protected on a large scale by treated bednets as *An. sinensis* was diverted to cattle or other animals. The vectorial capacity of *An. sinensis* greatly decreased due to reduction of the human blood index on large scale bednet treatment with very high percentage of coverage among the population.

The malaria incidence rate is generally lower in China than in other countries where treated bednets were used. Transmission is generally at a low rate and each new infection causes a distinct malaria attack. Many of the trials in other countries were in areas of high, or seasonally high, transmission where the relationship between sporozoite inoculation, parasitemia and morbidity is indistinct because of the occurrence of partial immunity and super-infection. According to the models of Macdonald (1957) and Moskovskil (1982), and actual observations made in the Garki project (Molineaux and Gramiccia, 1980) with a high degree of endemicity, large changes in vectorial capacity may produce little apparent effect, whereas in areas with low or moderate endemic levels, a relatively small change in vectorial capacity may decrease the incidence of malaria greatly.

Malaria is seasonally transmitted in most parts of China. In areas with marked seasonal malaria transmission, the most effective control strategy will probably be a combination using treated bednets and anti-malarials (Greenwood, 1988). Anti-malarials have been widely distributed nation wide in China. Local village doctors and village health volunteers and even some farmers distribute anti-malarials. Thus, whoever suffers from malaria can get anti-malarials easily: there has been no charge for patients who suffer from malaria.

During bednet treatment, special attention has to be paid to the organizational aspects in order to achieve large-scale effectiveness of this technology. Not only technology but also planning, management and operations must be adapted to local conditions. Village-based primary health care programs seem to be the best ways for use of mosquito bednet treatment to control malaria and its vectors. China has developed a primary health care infrastructure covering the whole country. Within this system, a mechanism for coordinating community workers of volunteers and government health bodies at the local level has opened the way for rural communities to participate directly in the use of treated mosquito bednets.

Bednets treated with pyrethroids for malaria control are cost-effective. The cost of the impregnation of existing bednets is considerably less than treatment with DDT indoor residual spraying. According to Li *et al* (1989), the cost of bednet impregnations was $ 0.065 per person/year, in contrast, DDT residual spraying cost US$ 0.15 per person/year in Guangzhou, China. The experimental results also showed that deltamethrin treatment of people's own nets cost only one quarter of the price of spraying the same houses with DDT in Sichuan Province, China (Cheng *et al*, 1995). Bednet treatment does not need sophisticated equipment and could be introduced through community effort. Malaria control through bednet impregnation may be as effective as or more effective than DDT indoor residual spraying (Curtis, 1990).

As mentioned above, malaria incidence in China is now generally very low. Bednets treated with pyrethroids for malaria control through the well developed primary health care infrastructure system makes use of a high percentage of bednets treated with pyrethroid on a very large scale possible. It can reduce vectorial capacity and hence may decline the incidence of malaria greatly. Furthermore, treated bednets also have a beneficial effect on flea, lice and bedbug populations and other vector-borne diseases such as Japanese encephalitis (Luo *et al*, 1994 b, c). At the same time, malaria control through bednet treatment is cost-effective.

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