



CHAPTER 3

RESEARCH METHOD

Some studies on the effect of Permethrin treated bednets were conducted in different areas in Vietnam. Permethrin treated bednets showed effective in preventing malaria disease in some places. Now, we based on the available data from those experimental studies in 1994 to calculate the cost - effectiveness, cost - benefit of the Permethrin treated bednets and untreated bednets measures in Long An and Song Be provinces

3.1 Operational Definitions

3.1.1 Effectiveness

Disease Indicators

- Number of malaria cases before intervention
- Number of malaria cases after intervention
- Number of patients avoided from malaria

Vector Indicators

- Density of Anopheles: No of mosquito/man/hour
- Densities of indoor and outdoor Anopheles species before intervention
- Densities of indoor and outdoor Anopheles species after intervention

3.1.2 Classification of Costs

The cost of goods or services is the value of the resources spent for the acquisition of those goods or services. For certaining purpose, all the input costs can be classified in these different ways.

Direct versus Indirect Cost

In the Health sector, the direct cost is linked directly to illness and its treatment or is economic cost due to premature death, reduced productivity, absence from school.

Capital versus Recurrent Cost

Those resources that have a life expectancy of one year or more are called capital costs. They may include building, cars, trucks, and some medical equipment. Those resources that are purchased and used (or replaced) within one year's time are recurrent cost

Provider versus Patient Cost

In this study, the provider side paid all costs of treating bednets including insecticide, labor cost of treating bednets, and equipments used. The impregnation was done by provincial health staff and the labor cost was calculated based on their salaries. In terms of treatment, the provider side covered all costs for services, tests and anti-malarial drugs that were borne by the Government for this study. For non-antimalarial drugs, patients had to pay and this was considered patient side. Due to the fact that the number of malaria severe cases and deaths was not included in this study, the income loss calculated involved only mild cases. The patients with mild malaria were usually absent from work for 5 days and did not need caretakers except for the children under 9 year old. Their relatives therefore can keep on working.

In some other studies travel cost in patient side was included, but in this study we considered only mild patients who had not to go to hospital and could get commune health center for treatment. That is why we did not mention travel cost. Pre-intervention survey showed local people had adequate bednets and used them. Therefore, the patient's cost included bednets cost. On the other hand, when being sick, patient usually followed a diet rich in calories and nutrients that can be calculated as food cost for patient side.

3.1.3 Calculation of Itemized Provider Cost

Capital Cost

If the inflation rate is i /year and remains unchanged though the next n year, the value of the equipment at the end of the n^{th} year will be:

$$\text{Current cost : } C_n = C_o \times (1+i)^n$$

i : inflation per year

n^{th} year

By the end of the n^{th} year, we need to have saved amount equivalent to C_n in order to replace the old equipment. And in terms of the opportunity cost, C_n must be considered if we save that money into the bank to get interest rate till the end of the life time of asset.

Annual cost : Current cost $\times r / [1 - (1/(1+r))^n]$

r : interest rate per year,

n : life of assets

The capital costs in this study included:

- Furniture used in Health center
- Building cost of Health center
- Medical equipment used in Health center

These assets were only used for outpatient services so the capital cost was divided by the number of outpatient's visits in one year and microscope cost was divided by the number of test in one year.

Recurrent Cost: Cost of Permethrin Used for Treating Bednets

Full costs of Permethrin were calculated by real price of Permethrin plus 10% of real price and transport cost.

$$C_{per} = \sum [P_{per} \times Q_{per} + (P_{per} \times Q_{per}) \times 10]$$

100

P: Real price; Q: Quantities of Permethrin used

Recurrent Cost: Labor Cost of Treating Bednets

The cost of treating bednets was calculated based on the salary of provincial health staff and the number of bednets that they can treat per day. Therefore, we can calculate the cost of treating one bednet and due the simple technique for treating bednets we can do this anywhere (in the yard, garden..., we do not need to do this in building).

Recurrent Cost: Equipment for Treating Bednets

The equipment for treating bednets included: plastic bowls, buckets. Their price are cheap and even they can last for more than one year but in reality they often used in one year, so they were calculated as recurrent cost.

Recurrent Cost: Anti-malarial Drugs

Cost of drugs were different between two kinds of parasite that patients got them. The full costs of drugs included the real price of drugs plus 10% of real price, the transport cost, and doses of drugs used that varied according to the patient's

weight or age. In this study, we only have data of age group < 9 years old and they were not specified in age by age; so, average dose of patients < 9 years was calculated by half of dose of adult patient.

$$C \text{ drug} = \frac{\sum [P \text{ drug} \times Q \text{ drug} + (P \text{ drug} \times Q \text{ drug}) \times 10]}{100}$$

P : Real price

Q : Quantities of each kind of drug used

Recurrent Cost: Salary

- List the personnel in Health center: There were only 3 nurses in Health center who served all outpatients in these communes
- Record their salaries and bonus per month
- Record the total visits of all patients with different diseases in these communes per year in Health center
- Calculate the cost/visit
- Calculate the cost of personnel in Health center used for malaria disease

Recurrent Cost: Maintenance of Building

- Record the price for maintenance Health center in one year
- Determine the proportion used for malaria disease

Recurrent Cost: Operational Cost

- Record the operational cost for one year
- Determine the proportion of cost used for malaria disease
- Medical supplies used for diagnosed malaria disease
- List all medical supplies and their quantity
- Record the real price plus 10% of transport fee
- Calculate the price used for malaria test

3.1.4 Calculation of Itemized Patient Cost

Direct Cost: Bednet Cost

- Record the quantity of each each kind of the bednet

- Record the real price of each type of bednet and added 10% of real price (the transport cost)
- $C_b = \sum [(P_m \times Q_m) + (P_m \times Q_m) \times 10/100]$
- Where P_m : Price of each type of bednet
- Q_m : Quantity of each type of bednet
- Record the life time of bednet and use the above formula to calculate the annual cost

Direct Cost: Drug Cost

Patient only paid the non - anti malarial drugs

- List the patient in each group
- Record drugs and quantity of each type of drug used by patient
- Record real price of drug and added 10% of real price (transport cost)
- $C_d = \sum [(P_m \times Q_m) + (P_m \times Q_m) \times 10/100]$

Direct Cost: Cost of Food (CF)

Special cost for food due to illness and treatment

- Average money for special food of a patient per day
- Average illness days/patient
- The number of patient

Direct Cost: Travel Cost

In this case, we did not calculate the travel cost because the Health center is not far from their houses, they were able to walk or their relatives took them to Health center by bicycle

Indirect Cost

Indirect cost is mainly not going to work. It's calculation depends on the occupation of the patients or relatives

Patients who are farmers

- Estimate income by money term from selling total products. That was total household's income per year
- Estimate farmer's income by dividing total household income by number of individuals who worked to earn it

- Estimate number of working days per month
- Calculate patient's income loss per day

Patients who are workers

- Record their salaries, any allowance and other income received per month
- Estimate income loss per day by dividing their income per month by 26 days (number of working days per month)

Patients who are fishermen

- Estimate income by money term from selling total product. That was total household's income per year
- Estimate fisher's income by dividing total household income by number of individuals who worked to earn it
- Estimate number of working days per month
- Calculate patient's income loss per day

Patients who are foresters

- Estimate income by money term from selling total product. That was total household's income per year
- Estimate forester's income by dividing total household income by number of individuals who worked to earn it
- Estimate number of working days per month
- Calculate patient's income loss per day

Caretakers or Relative of the patients

In this case, we only calculate the income loss of persons who take care of sick children (3 days on average). We did not mention severe patients and in fact, the number of severe cases in these provinces were very few, so we did not calculate the costs of severe, death cases. (The cost/day is calculated like above)

3.1.5 Calculate The Cost - Effectiveness and Cost - Benefit Ratio

Cost – Effectiveness

There was a difference in population between the Permethrin impregnated bednet and untreated bednet groups. Therefore to avoid wrong conclusions that could be drawn if crude or unstandardized malaria rates were used, we applied the direct method of standardization as shown below:

- From a new standard population. For simple calculations, the higher population was used as standard population between the selected populations.
- Calculate expected number of malaria patients before and after intervention based on standard population

Given A = Expected No. of patients before (or after) intervention in standard population

B = No. of malaria patients before (or after) intervention

Pop(s) = Standard population

Pop = Population (not standardized)

We have the formula :

$$A = \frac{B \times \text{Pop}(s)}{\text{Pop}}$$

E = Expected number of subjects prevented from malaria

E = Adjusted No. of patients before intervention – Adjusted No. of patients after intervention

$$\text{Cost- effectiveness ratio} = \frac{\text{Total cost of each intervention}}{E}$$

Cost - Benefit

- Calculate the cost of treating bednets (C)
- Calculate the avoided cost (B)

Calculate the number of avoided cases by applying the formula

$$z \times (y - x) / 100$$

$$x = a/z \times 100$$

where a : No. of patients used treated bednets

z : No. of people used treated bednets

$$y = b/c \times 100$$

where b : No. of patients used untreated bednets

c : No. people used untreated bednets

Avoided cost for provider = No. of avoided cases \times cost per case of patient treatment

Avoided cost for patient = No. of avoided case \times patient cost per case

Avoided cost = Avoided cost for provider + Avoided cost for patient

▪ B/C ratio = Avoided cost/Cost of treating bed nets

3.2 Conceptual Framework

Many studies on Permethrin treated bednets in the world as well as in Vietnam showed that this measure can reduce malaria incidence. In the context of current global malaria situation with limitations of house residual insecticide spraying, the introduction of such a new measure for malaria control deserves special attention. However, in addition to the promising technical features of the measure, there is also a need for considering its role from the viewpoint of health economics.

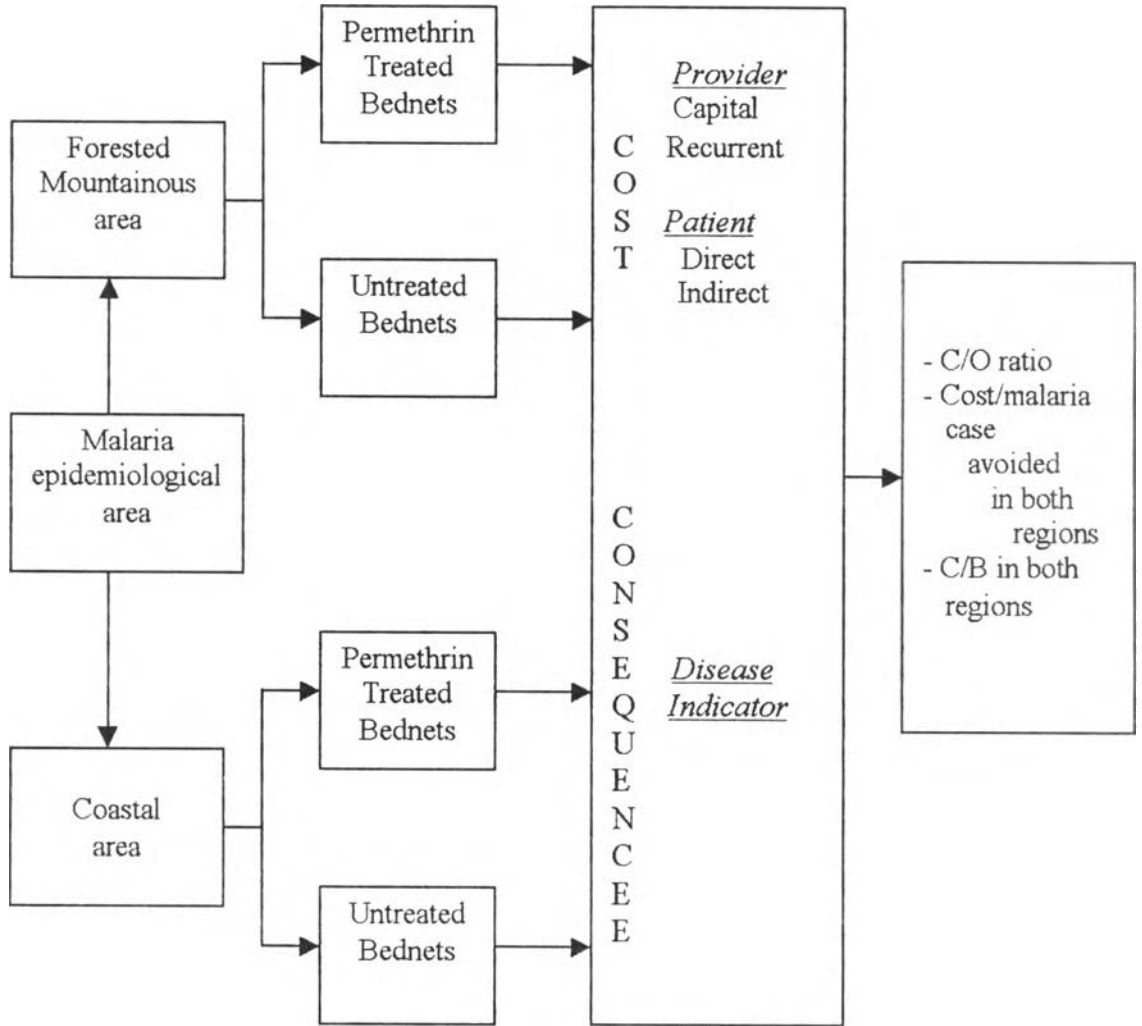
Based on characteristics of different epidemiological regions in the Southern part of Vietnam, we can classify them into two main areas: forested-mountainous and coastal. These two areas are different in terms of parasite and vector species. In this study, Long An, a representative province for coastal area and Song Be for forested-mountainous area were selected for applying village-scale Permethrin impregnated bednet measure and for analyzing the cost – effectiveness and cost – benefit between the treated and untreated bednet measures.

The following steps were done during the process of analyzing cost – effectiveness and cost - benefit of the measure involved:

- Identify the cost and its components in each measure
- Identify the effectiveness of each measure
- Calculate the cost - effectiveness of each measure
- Calculate the cost - benefit of each measure

Conceptual Framework is summarized in Figure 3.1

Figure 3.1 Conceptual Framework of Permethrin Treated Bednets Measure



3.3 Research Methodology

A cohort study was conducted in 1994 to calculate the cost of two measures in Long An and Song Be provinces

3.3.1 Study Areas

This study was conducted in Tan Tap, Long Huu Dong communes, Long An province (representative for coastal area), and Thong Nhat, Nghia Trung communes, Song Be province (representative for coastal area). The maps show study sites are presented in Appendix 1.

In reality, we cannot choose two similar places, but we need minimize the confounders that affect the results of this study.

Based on the characteristics of Tan Tap and Long Huu Dong communes above. Tan Tap and Long Huu Dong were selected for study in the coastal area; Nghia Trung and Thong Nhat were selected for study in the forested area.

3.3.2 Study Population

Long An province: All households in Tan Tap commune used Permethrin treated bednets (there were 538 bednets consisting of 409 double and 129 single ones). While all households in Long Huu Dong used untreated bednets (there were 580 bednets consisting of 400 double and 180 single ones)

Song Be province: All households in Nghia Trung commune used Permethrin treated bednets (there were 540 bednets consisting of 410 double and 130 single ones). While all households in Thong Nhat commune used untreated bednets (there were 575 bednets consisting of 395 double and 180 single ones)

The summary of baseline information of Tan Tap and Long Huu Dong communes (Long An province) and Thong Nhat and Nghia Trung communes (Long An province) were presented in Table 3.1

**Table 3.1 Baseline Information Between Treated Bednets
and Untreated Bednets**

Baseline	Long An province		Song Be province	
	Treated Bednets	Untreated Bednets	Treated Bednets	Untreated Bednets
Population	1,338	1,342	1,318	1,331
No. of households	250	271	253	267
Average No. of Subjects/household	5.3	4.95	5.2	4.98
Sex ratio (F: M)	F: 686 ; M: 652	F:711; M : 631	F: 637; M:681	F:674: M: 657
No. of children < 9 years	334	338	346	346
The main occupation	Farmer (70%), fishermen (18 %)	Farmer (70%), fishermen (18 %)	Farmer (90%) Forester (10%)	Farmer (90%) Forester (10)
Average annual income/person (VND)	2,000,000	2,000,000	2,159,370	2,159,370
The coverage rate and the rate sleeping under bednets	100%	100%	100%	100%
Sleeping time	8 PM – 9 PM	8 PM – 9 PM	8 PM	8 PM
Awaking time	5 AM – 6 AM	5 AM – 6 AM	5 AM- 6 AM	5 AM- 6 AM
API before intervention (per thousand)	291.47	256.33	336	346
Parasite structure	P.F: 43.58 %; P.V:56.42%	P.F : 47.67%; P.V : 52.33%	P.F : 81.67% P.V : 18.33 %	P.F: 80.92% P.V : 19.08%
The main vector	An.sundaicus, An.subpictus	An.sundaicus, An.subpictus	An.dirus An.minimus	An.dirus An.minimus
No. of people before intervention	390	344	443	388

Note: From the baseline information, we see that Long Huu Dong, Tan Tap (Long An province) and Thong Nhat, Nghia Trung (Song Be province) also have the same characteristic about geography, people's habit, income, parasite structure, and the species of Anopheles and the same with Thong Nhat and Nghia Trung. That's why, we select Long Huu Dong, Tan Tap in Long An and Nghia Trung, Thong Nhat in Song Be for study to minimize the confounders.

3.3.3 Required Information and Its Source

Table 3.2 Information and its sources

Information	Sources
<u>Information on population</u>	
Number and structure of population	District Statistics
Main occupation of population	District Statistics
Coverage rate and habit sleeping under bednets	KAP survey before intervention
<u>Information about epidemiology</u>	
API	Monthly, quarterly and yearly District Report
Parasite structure	Id
Number of visits in Health center in one year	District Health center records
Number of tests in Health center in one year	Id
Number of malaria cases in each age group visiting Health center in one year	Id
Average duration of illness due to malaria	Malaria Case Records
Average absence days due to taking care of patients	Interview
Vector borne disease indicator	Entomology Report
<u>Economic parameters</u>	
Domestic rate of inflation, interest, exchange rate	National bank, Chamber of Commerce
Items, life time of items and cost of items	Interview of Health center staff
Income of person/year,	District Statistics
Spending for malaria disease: Food/day, drug/case	Interview
<u>Information about activities of Health center staff</u>	
Number of staff	District's Personnel Section
Salary, bonus of staff, working days per year	Id

Note: KAP = Knowledge Attitude and Practice

3.3.4 Calculate The Sample Size

Using the following formula:

$$N/\text{group} = \frac{2 (Z_a + Z_b)^2 p(1-P)}{(P_1 - P_2)^2}$$

$$p = (P_1 + P_2)/2$$

The level of significance (α level) = 0.05

The power ($1 - \beta$) = 0.95

In Long An (Tan Tap, Long Huu Dong communes)

The expected incidence rate in treated bednets group: $3.211 \times 15/100 = 0.0048$

The expected incidence rate in untreated bednets group: $3.43 \times 80/100 = 0.0274$

$$P = (0.048 + 0.0274)/2 = 0.0161$$

$$\frac{2 \times (1.96 + 1.96)^2 \times 0.0161 \times (1 - 0.0161)}{(0.0274 - 0.0048)^2} = 953$$

Minimum sample size : 953 persons for each group

In Song Be (Thong Nhat, Nghia Trung communes)

The expected incidence rate in treated bednet group: $3.26 \times 10/100 = 0.0033$

The expected incidence rate in untreated bednet group: $3 \times 80/100 = 0.024$

$$\frac{2 (1.96 + 1.96)^2 \times 0.01365 \times (1 - 0.01365)}{(0.024 - 0.0033)^2} = 965$$

Minimum sample size : 965 persons for each group

3.3.5 Method of Data Analysis

Cost - Effectiveness Analysis

Cost - effectiveness analysis is a comparison between the cost of different measures to achieve an unit effectiveness which is the cost of each measure divided by its effectiveness or called cost - effectiveness. The more cost - effectiveness measure is that for which the lower cost per unit of effectiveness is achieved.

Cost - Benefit Analysis

Compare the cost and its benefit. Both cost and benefit are expressed in the same unit (usually in currency), and they are used to determine either ratio of money spent to money saved or the net saving.

Sensitivity Analysis

To measure the cost and benefit in different circumstances:

- Changes in the habit of sleeping under bednets

Two another communes were chosen for study: Tho Son and DakNhau. These two communes are in the same district with NghiaTrung and Thong Nhat, they have the same characteristics with Nghia Trung, Thong Nhat except that there is a group of minority ethnic, namely Monong, Stieng. The literacy of people over the age of ten in these two communes were 60% and habit of sleeping in the bednets was lower (60%).

- Changes in the occupation of the people

One more study was conducted in Phu Rieng rubber company in Song Be. In this place, due to requirement of work, the workers must work outdoor; therefore, they were more likely to get exposed to mosquito bites.

3.3.6 Statistical Significant Test

The study included two independent groups; so, the Chi quare test was used to test the statistical significance of outcome between the two measures.