CHAPTER 4

DISCUSSION

The simulation modelling for analysis of cost and outcomes from introducing an "on the spot malaria diagnostic test" provides a powerful instrument for rapid appraisal of any technique as such. The use of data on malaria diagnosis and treatment as well as on the ParaSight test collected from the Thailand Malaria Division for running the modelling program proves at the same time the feasibility of the simulation modelling and some preliminary observations about the ParaSight test.

1. Feasibility of the Simulation Modelling

The simulation modelling is based on a computer program using foxpro software working on 1 database and 1 program file.
This program helps calculating the present value of future expenses and outcomes on a defined interest rate. From a set of input data, the program on running gives a set of output data.

* Cost (capital cost at field and upper level, fixed cost at field and upper level and variable cost at field and upper level)

* Benefit (saving of external cost, saving of prevented presumptive treatment, saving of prevented self treatment).

The program gives also intermediate information based on theoretical data which can be compared with real data. Running the simulation with input data of 1988, a series of intermediate information can be obtained for comparison with real data from 1988 to 1992.

The comparison between theoretical data and real data (marked with a star *) shows a very close similarity. This allows forecasting of cost and outcomes from introducing a new test within the time frame from 1992 to 2001.

Regression correlation between malaria positive cases and number of test performed helps the quantity of test on a predicted quantity of positive cases. (Table 2)

Table 2. Number of Positive Case and Number of Tests per Positive Case

Year	1988	1989	1990	1991	1992
Population (in 1000)	51,305 *51,305	51,741 *52,065	52,180 *52,625	52,623 *53,051	53,501 *53510
Incidence (X)	6.71 *6.71	5.8 *5.4	5.0 *5.18	4.3 *3.74	3.7 *3.15
Number of positive case	344,250 *344,250	289,749 *281644	260,900 *272643	226,278 *198383	196,355 *168370
No.of test positive case (Y)	22 *23	25 * 26	27 *26	30 *32	31 *33

2. Preliminary Application to the Parasight Test

The advantages of the ParaSight test rely on its low capital cost. This makes the benefit/cost ratio the same in the short run and in the long run.

While the cost of kit per test is thought be high (25 Baht/one), the break event point analysis can show what cost could be accepted with or without consideration of treatment. Test specificity influences variable cost and benefit/cost ratio. The increase of test

specificity is of importance.

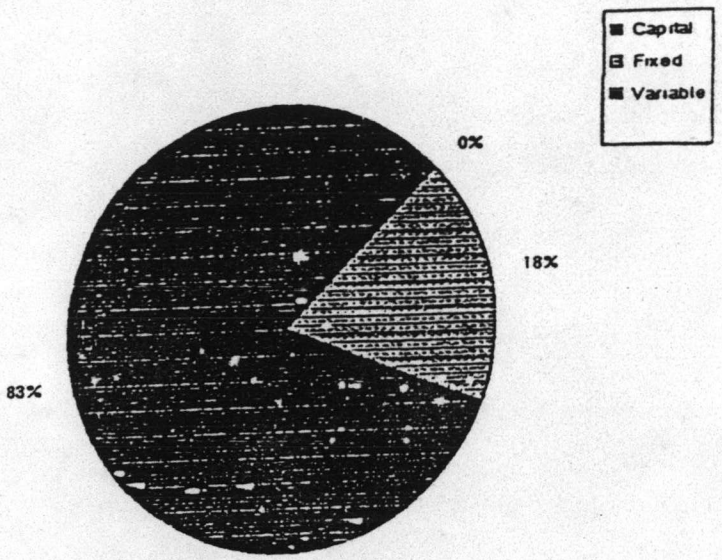
The test can be performed by health workers or village malaria volunteers. If change in labor cost can make change in fixed cost and benefit/cost ratio, the involvement of village malaria volunteers is of significance because village malaria volunteers do not request wages. Therefore, this analysis puts emphasis on:

- Cost structure;
- Relationship between benefit/cost ratio and time frame;
- Analysis of break event points;
- Relationship between test specificity and benefit/cost ratio, and
- Relationship between labor cost and benefit/cost ratio.

Cost structure (The result of the first year is as example):

	Amount	Percentage
Capital cost	229,435	0.135
Fixed cost	30,617,700	18.082
Variable cost	138,484,340	81.783
Total cost	169,331,475	100.00

Figure 13. Cost Structure of ParaSight Test



The above table and picture show that Capital cost is of no importance, Fixed cost is much lower than variable cost and Variable cost is the major part of the cost structure.

Time frame

As the major part of the cost structure is variable cost, it seems that no change occurs in the benefit/cost ratio in the short run and in the long run:

Time frame	Benefit/cost ratio
1 year	7.91
4 year	7.91
7 year	7.91
10 year	7.92

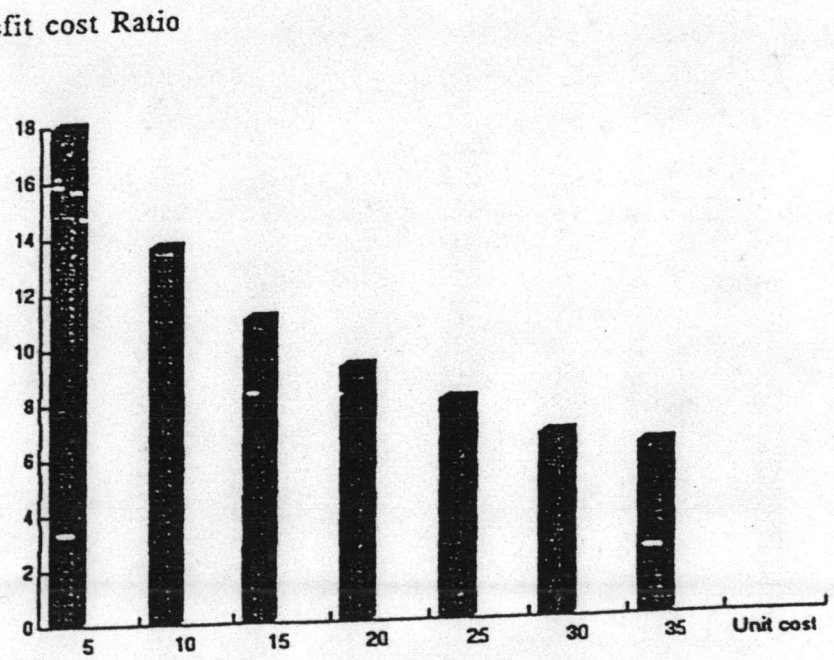
Considering results related to drug resistance, benefit in the long run would be of greater importance. It could have more impact on social benefit.

Relationship between test kit cost and benefit/cost ratio

As above shown, variable cost is the major part of the cost structure and test kit cost is the major part of the variable cost. Consequently, kit test cost influences cost and benefit/cost ratio.

Unit cost	Benefit/cost ratio
5	17.88
10	13.59
15	10.97
20	9.19
25	7.91
30	6.62
35	6.18

Figure 14: Test Cost and Benefit-Cost Ratio.



Break event point analysis

It is thought by Malaria Division that test kit cost of 25 Baht is high. The problem is what cost can be accepted. The analysis of break event points can give the answer.

Considering the cost of the current technology (Blood slide - Bs) as the accepted cost level being as follows (Source for one year):

* Consumable: 4,227,30 test * 7 Baht	= 29,591,100
* Labor :875 microscopists * 6000 * 12	= 63,000,000
* Space: 875 * 500 * 12 Baht	= 5,250,000
* Equipment: 875 * 4000 Baht	= 3,500,000
* Administration: 20 % of above	= 20,268,220
Total:	= 122,300,780 Baht
	= 122,300 * 10^3

In the rectangular coordinates,

Y = total cost by 50 million scale
X = unit cost by 2 Baht scale

Draw a line (A) parallel to x absciss cutting the ordinate at point 122 million being total cost of Blood slide test.

Draw line (B) expressing the linear correlation between unit test cost and total cost of Parasight test as follows :

Unit cost (X)	Total cost (Y)
10	98,513,475 = 98,513 * 10^3
12	107,955,875 = 107,956 * 10^3
14	117,398,275 = 117,398 * 10^3
16	126,840,675 = 126,841 * 10^3
18	136,283,075 = 136,283 * 10^3

20	145,725,475 = 145,725 * 10^3
22	155,167,875 = 155,168 * 10^3
24	164,610,275 = 164,610 * 10^3
26	174,052,675 = 174,053 * 10^3
28	183,495,075 = 183,495 * 10^3
30	192,937,475 = 192,937 * 10^3
32	202,379,875 = 202,380 * 10^3
34	211,822,275 = 211,822 * 10^3
36	221,267,675 = 221,268 * 10^3
38	230,701,075 = 230,701 * 10^3

Line B being Y = 51,302 + 4,721 X (with r= 1). Line B cuts line A at point M. The cutting point M gives the answer which unit test cost can be accepted at the cost of 15 Baht, without taking into account cost savings due to reduced drug use.

Draw line (C) expressing the linear correlation between unit test cost and net total cost of ParaSight test being total cost minus savings from reduced drug costs (95,864,230 = 95,864 * 10^3).

The drug saving cost does not depend on unit cost of the kit, it is a constant number while total cost of ParaSight test is variable. As the difference between initial total cost and drug saving cost is the net total cost, the cutting point between line C and line A will shift to the right in comparison with the cutting point between line B and line C.

Line C can be determined from data as follows:

Unit cost(X)	Net total cost (Y)
10	2,649,245 = 2,649 * 10^3
12	12,091,645 = 12,092 * 10^3
14	24,534,045 = 24,534 * 10^3
16	30,976,445 = 30,976 * 10^3
18	40,418,845 = 40,419 * 10^3
20	49,861,245 = 49,861 * 10^3

22	$59,303,645 = 59,304 * 10^3$
24	$68,746,045 = 68,746 * 10^3$
26	$78,188,445 = 78,188 * 10^3$
28	$87,630,845 = 87,631 * 10^3$
30	$97,073,245 = 97,073 * 10^3$
32	$106,515,645 = 106,516 * 10^3$
34	$111,958,045 = 111,958 * 10^3$
36	$125,400,445 = 125,400 * 10^3$
38	$134,842,845 = 134,843 * 10^3$

Line C being the correlation regression between unit test cost and net total cost;

$$Y = -43,129 + 4,659\ X \text{ (with } r = 0.999)$$

Draw line C: Line C cuts line A at point N. The cutting point N gives the answer which unit test cost price can be accepted when drug saving is taken into consideration. This is 35.5 Baht. Thus, calculation of savings due to reduced drug costs would permit a higher test unit cost at break even point. This is an important consideration in view of the expected reduction of morbidity and mortality that should follow from rapid on the spot diagnosis. This additional outcome has not, of cause, been calculated here.

If we had data in order to extend the benefit to include saving from prevented drug resistance, we could get more supportive argument in favor of the ParaSight test.

Figure 15: Break event points
(Line)

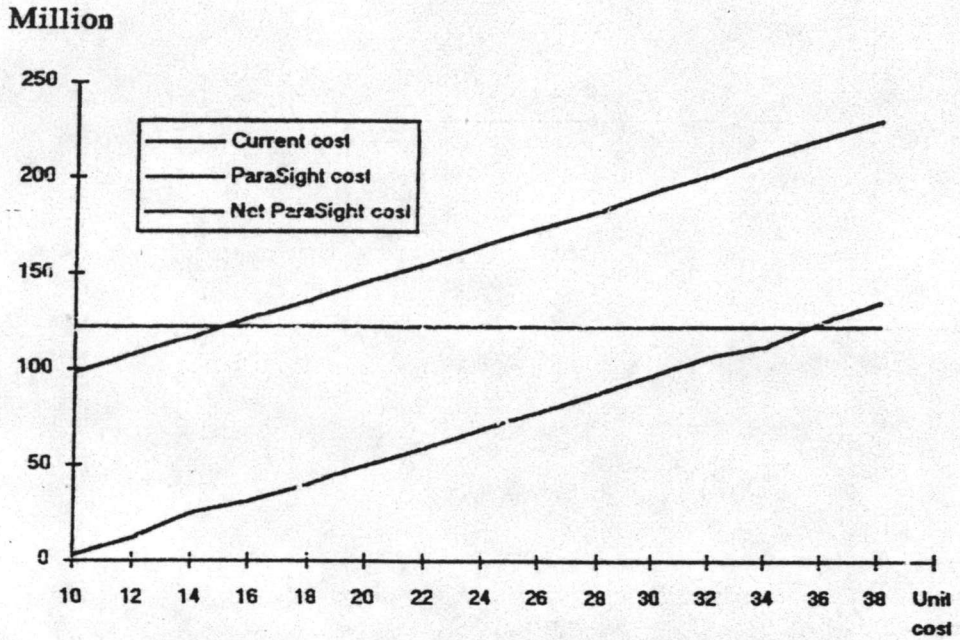
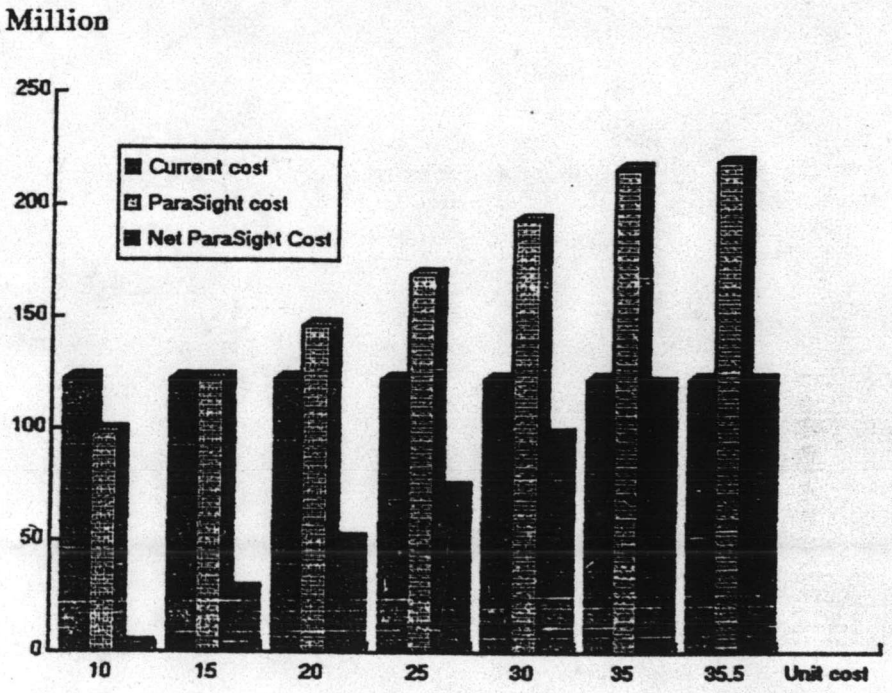


Figure 16 : Break event points
(Column)



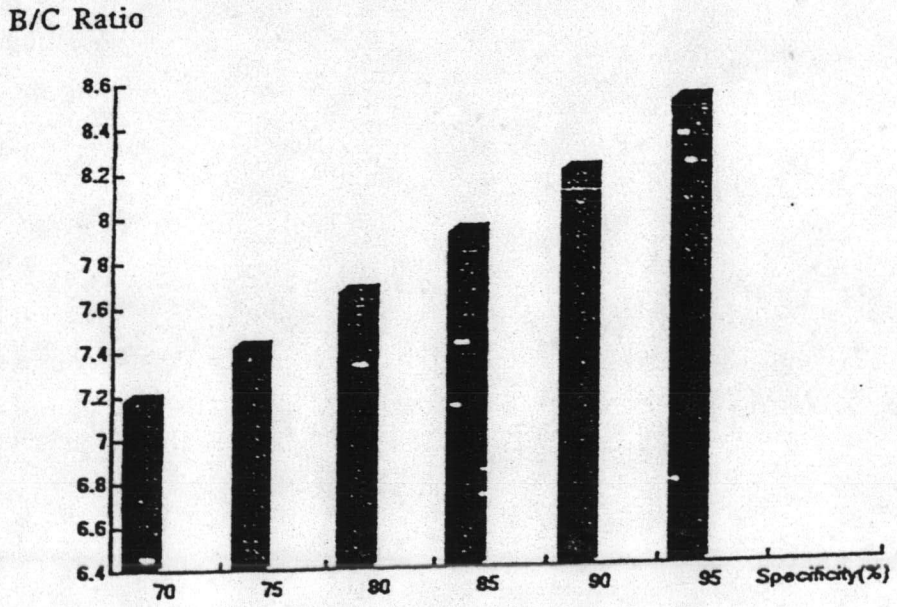
Relationship between test specificity and Benefit/Cost ratio

Low test specificity requires more cost for false positive cases. Improvement of test specificity will reduce false positive cost and increase Benefit/Cost ratio.

Relationship between test specificity and Benefit/Cost ratio is shown in the table as follows:

Test Specificity	Benefit/Cost ratio
70%	7.18
75%	7.41
80%	7.65
85%	7.91
90%	8.18
95%	8.48

Figure 17. Test Specificity and Benefit-Cost Ratio.



Relationship between labor cost and Benefit/Cost ratio

It is found that:

* Benefit/Cost ratio= 9.34 if the test is performed totally by village malaria volunteers. In this case, salary for test performers is of no importance or is null.

* Benefit/Cost ratio= 8.6 if the test is performed half by health workers and half by village malaria volunteers. In this case, only half of health worker salary has to taken into account, being 2,000 Baht/month.

* Benefit/Cost ratio= 7.91 if the test is performed totally by health workers. In this case, the whole health worker salary has to be taken into account, being 4,000 Baht/month.

Effects on external costs

The above consideration examine the effects of introducing of the ParaSight test on provider costs. However, as shown in figure 12 the large contribution to saving is from reduction of external costs. These savings represent the sum of savings of opportunity costs plus savings of travel costs. These have not been considered, for example, in the break event point analysis: if included, these points would move further to the right in figures 15 and 16. If it were possible to calculate accurately the savings from reduced morbidity and mortality, these factors would further increase the benefits.

3. Limitations of the Study

Clearly, in practice, many variables will shift in value over a range. In this process of testing the model here, most variables have been assigned single unit values for convenience. In applying the model to different countries or regions at different times, the appropriate real value for each variable should be used.

The model does not claim to examine all possible variations in benefits. Emphasis has been placed on reduced drug consumption, to illustrate the influence of one major cost external to the test process itself. This is an intermediate outcome. While there should also be final outcomes (eg. reduced morbidity, reduced mortality, reduced drug resistance, increased productivity), these are outside the objectives of the study and should be the subject of further application of this model or alternative models.

If a decision is made to introduce a rapid on the spot diagnostic test into a national malaria control program,there would of necessity be a period during which the existing blood smear based diagnostic system would operate in parallel with the new test. During this period the costs of both test systems would be compounded, resulting in an increase in total costs of the control program, before a decision could be made to phase out routine blood smear diagnostic tests, retaining blood smears only for quality control, at which point in time costs would be substantially reduced. The present model needs to be adapted to permit testing of this dynamic time period, in order to allow calculation of real long term costs during the transition period and thereafter.