CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Conceptual Framework

This study has objectives to analyze the cost of rabies control in Thailand in year 2000, which are the combination of many activities. They are categorized into 2 main groups; (1) costs of human postexposure treatment, (2) costs of dog rabies control.

Costs of human postexposure treatment, in view of the study, they will be analyzed only the exposed persons to rabies disease or suspected case. The researcher does not take pre-exposure treatment and cost incurred by outbreak control into account. Costs of human postexposure treatment are comprised of postexposure vaccination, treatment for rabies patient, treatment for immunoglobulin side effect and laboratory investigation for rabies in human.

Costs of dog rabies control are comprised of several activities. The researcher has grouped them into 3 major activities; (1) dog vaccination, (2) epidemiological surveillance and (3) other programs (i.e. dog population management, health education and related campaigns).

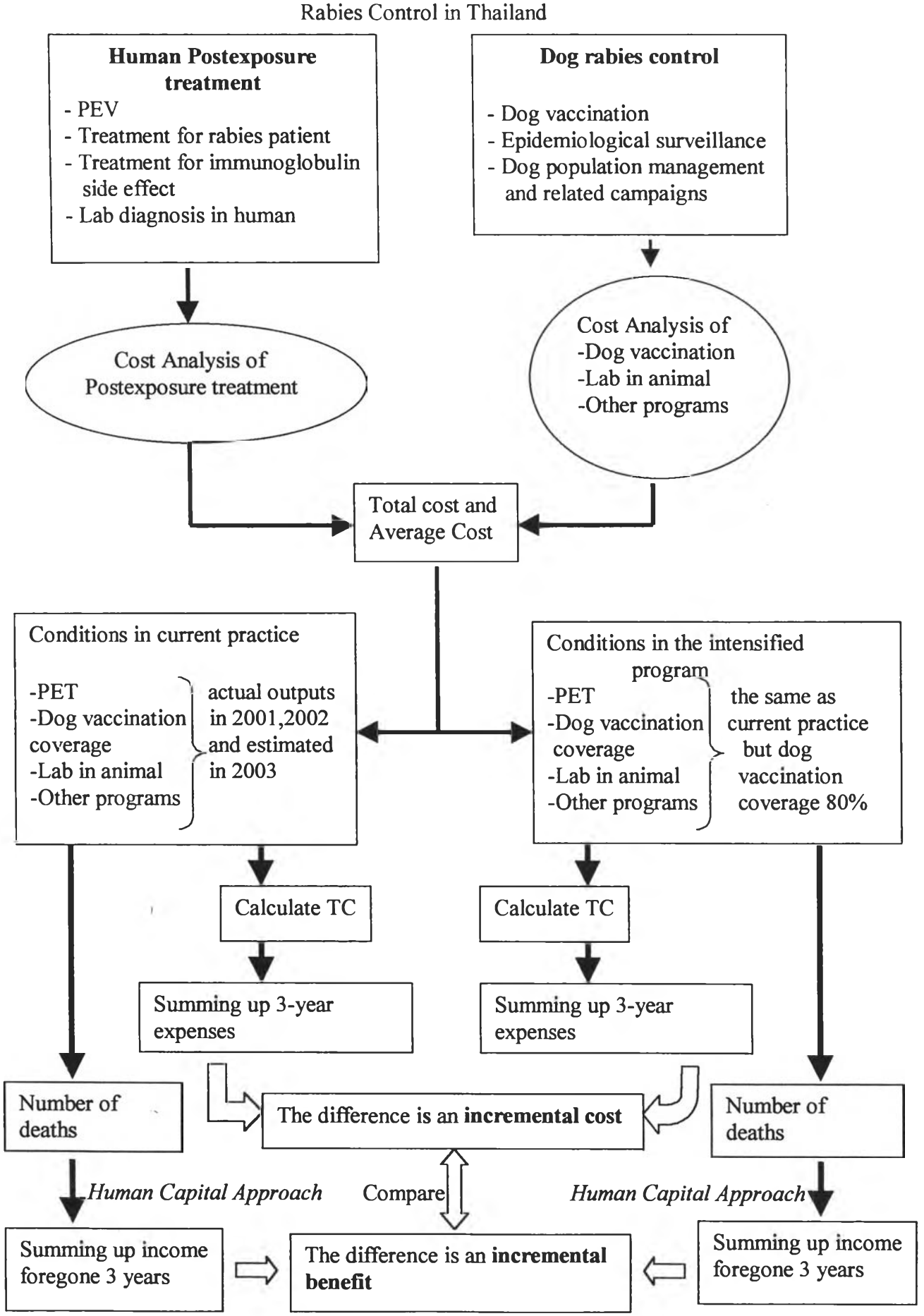
All activities mentioned above are undertaken by many organizations, both public and private sectors. By this reason, the study will be started by analyzing organization-by-organization and then total cost and average cost will be synthesized into country's picture.

Furthermore, the researcher has designed a model to estimate cost of the intensified-dog control program that is expected to incur in case of the government policy to eradicate rabies from Thailand. And also make comparison to a benefit gained, human life that could be averted from death valuing into monetary term.

Cost of the intensified-dog control program is actually an expense that will be accrued compared to cost of current practice (dog rabies control). The model is expected to implement 3 years and estimated the 3-year expenses from the intensified program. It is computed an expense from actual outputs for the past years and an estimate of output for the upcoming year. But under the intensified program, this model will compute an output of dog vaccination not less than 80% of its population at that year.

By comparison, an incremental cost of rabies control with more life saved, it will be discovered cost-benefit of the intensified-dog control program.

Fig 3.1 Conceptual Framework



3.2 Research Design

Descriptive study will be applied for these objectives. By increasing percentage of vaccination coverage of dog from actual outputs during year 2001-2003 to 80% is to attain herd immunity. The 3-year expenses will be estimated and compared incremental cost to the incremental benefit gained from life saved in term of productivity gained (income foregone). Then the sensitivity analysis of the results will be tested.

3.3 Methodology

3.3.1 Baseline data

1. Dog population and dog accessibility

A number of immunized dogs in Thailand collected by department of livestock development will be taken into account including survey data of total population of dogs. On the other hand, ratio of dog to human from previous study (Meesomboon V and Sagarasaeranee P in 1992) will be compared in this research.

Research carried out by WHO between 1981 and 1988 as part of the AGFUND/WHO project for the control of human and canine rabies in developing countries revealed that:[1]

- whether owned or not, very few dogs (generally less than 10-15% of the dog population) are able to avoid being caught;
- dog removal programs (in which stray dogs are captured and humanely killed) are ineffective, as well as costly;
- vaccination coverage rates of 75% or higher can be attained, although this requires special efforts in mobilizing community participation, conducting health system research and providing health support services for vaccination campaigns.

So we can assume that around 80% of dogs are accessible to the intensified-program.

2. Postexposure treatment (PET)

A number of postexposure treatments will be collected from secondary data (Division of Communicable Disease) and divided into public and private providers. Regarding the meaning of treatment for exposed persons, it should be included rabies patient, treatment for complication from receiving immunoglobulin and cost incurred from rabies investigation in human.

3. Vaccine and immunoglobulin

This includes dog vaccine and human vaccine. Data on dose-vials and imported price in year 2000 will be retrieved from FDA Drug Control Division. Domestically produced rabies immunoglobulin will be collected from the QSMI.

3.3.2 Model conditions

1. The control of rabies in dog after implementing the intensified program

There are three basic elements to any program for the control rabies in dogs and other domesticated animals: [1]

1.1 Dog vaccination

Although rabies vaccine has its potency to protect for at least two years but as in state of endemic areas and rapid turnover of dog population vaccine application will be vaccinated every year. At least 80% of the dog population in each community should be vaccinated within a month. It has been found in many urban areas that vaccinating at least 80% of dog population led to the disappearance of human rabies cases. For this reason, 3 consecutive years of dog vaccination will be undertaken. Dog vaccination coverage is derived from an actual rate and estimated for upcoming year.

After rabies-free status was ensured, the maintenance vaccination of dog at particular risk (i.e. national borders) is still being continued.

Data of this activity will be collected from department of livestock development: MOAC, the Queen Saovabha Memorial Institute, Bangkok Metropolitan Authority, Local Government Authorities and veterinary private clinics.

1.2 Epidemiological surveillance

Surveillance of rabies is the basis of any program for rabies control.[1] Epidemiological data should be collected, evaluated, processed and mapped whenever possible and disseminated rapidly. Such data are essential both to physicians in deciding whether to initiate postexposure treatment and to veterinarians in deciding what measures to adopt towards the animal responsible for the contact.

The surveillance of rabies has at present reached a satisfactory standard in only few countries and this has a direct bearing on the treatment of exposed persons and on rabies control activities in animals.

There are mainly two methods in surveillance: active and passive. An active surveillance means surveying in the field study to study the prevalence of rabies in community's dogs; unfortunately in Thailand few projects was done and not be sufficient of data to generalize at country level. Therefore we will rely on passive surveillance.

In Thailand nowadays, epidemiological surveillance (passive method) is mostly derived from laboratory diagnosis of rabies in animal and human reported rabies disease.[6] So this model will use laboratory diagnosis of rabies in animal as a proxy of surveillance. Laboratory diagnoses in animal are derived from an actual rate and estimated for upcoming year.

Cost of laboratory diagnosis in animal will be collected from department of livestock development: MOAC, department of medical science: MOPH and the

Queen Saovabha Memorial Institute. Although other institutes such as some regional hospitals and two-university hospital are also able to investigate rabies in animal but only a few specimens were submitted. Therefore it is not included to this study.

1.3 Dog population management and other programs

WHO has expressed its strategy regarding dog population management in Annex 4 of the eighth report of the WHO Expert Committee on Rabies.[1] There are 3 recognized practical methods for dog population management: movement restriction, habitat control and reproduction control.

There is no evidence that removal of dogs has ever had a significant impact on dog population densities or the spread of rabies and is no longer considered effective direct control measures. The population turnover of dogs may be so high that even the highest recorded removal rates (about 15% of the dog population) are easily compensated for by increased survival rates. However reproduction control is still being kept to consider its cost.

In addition to other programs such health education and dissemination that also play an important role in rabies control will be taken into account. In this model the researcher supposes that these activities are still being run the same pattern.

All mentioned data will be collected from department of livestock development: MOAC, department of communicable disease control: MOPH, Bangkok Metropolitan Authority, Local Government Authorities and veterinary private clinics.

2. Postexposure treatment after implementing the intensified program

As observed in countries where effective rabies control activities are carried out, the number of PET increases during the 2-3 years following the first dog vaccination campaign, because of increased public awareness of the rabies threat, and then decreases. In Thailand the increase has been growing very quickly for several years ago[8] then during 3 years of program the researcher will adopt an actual rate, similar to current practice and estimate for the future year.

3. Effectiveness of a dog rabies elimination program on the number of human deaths

From the various canine rabies control projects coordinated by WHO, it seems realistic to assume that, in a given area, the number of human deaths would decrease quickly and reach zero level after 2-3 years, provided that a well planned comprehensive canine rabies control program is correctly implemented. It is logical that during the first two years of program implementation, death is still expected to be reported but not in the year 3rd.

4. Status of health infrastructure

It is assumed that, at the time of program implementation:

- the medical services are functioning and necessary health infrastructure have been established;

- the veterinary services are well organized and need only to proceed more animal vaccination services.

5. Conditions after the intensified program have been completed.

We anticipate that the program will be spent 3 years to complete and the 3-year program will change the situation of rabies in Thailand. As it is observed in many countries, along the borders must be close monitoring and vaccination campaigns are undertaken on an annual basis as immune-belt.[4] There still have PET in case of unreliable events; for example, unobservable dog or another canine bitten as was recommended by WHO but rate of postexposure vaccination will certainly decrease. Epidemiological surveillance is being continued and to signal in case of outbreak. Costs being incurred by these following conditions are beyond the scope of this model.

3.3.3 Cost analysis of rabies control.

Such costs can be mainly categorized into 4 groups; *total cost and cost per unit of PET, total cost and cost per unit of dog vaccination, total cost and cost per unit of laboratory diagnosis in animal, and total cost of other programs (dog control and campaign related to program).*

Among these costs we can group the organizations related to each activity:

- *Dog vaccination*: department of livestock development(DLD), Bangkok Metropolitan Authority (BMA), local government authority (LGA), the Queen Saovabha Memorial Institute (QSMI) and Veterinary private clinic;
- *Laboratory diagnosis in animal:* department of livestock development, department of medical science (DMSc), the Queen Saovabha Memorial Institute, five regional hospitals and two university hospital;
- *Other programs (dog population control and related activities):* department of livestock development, Bangkok Metropolitan Authority, department of communicable disease control (CDC), local government authority and Veterinary private clinic;
- *Human postexposure treatment (PET):* the Queen Saovabha Memorial Institute, department of medical science, public and private health facilities.

Algorithm was shown in figure 3.2

Costs of each activity are a combination of the followings.

1. Dog rabies control

1.1 Costs of Dog vaccination are comprised of

- Administration cost = Salaries (permanent staffs), Utilities, Material cost (office used), Capital costs (depreciation cost of building, equipment)
- Variable cost = Wage, Vaccine, Other materials (medical material)

1.2 Costs of Laboratory diagnosis in animal are comprised of

- Administration cost = Salaries (permanent staffs), Utilities, Material cost (office used), Capital costs (depreciation cost of building, equipment)
- Variable cost = Wage, Laboratory materials

1.3 Costs of other programs (Dog population control, Health education and related activities) are comprised of

- Administration cost = Salaries (permanent staffs), Utilities, Material cost (office used), Capital costs (depreciation cost of building, equipment, vehicles)
- Variable cost = Wage, Contraceptive materials, Public relation materials

2. Costs of Human Postexposure treatment (PET) are comprised of

- PEV cost = Vaccine, Wound care, Drug (antibiotics, tetanus toxoid, analgesic), other medical materials, Labor cost, Capital costs
- Cost of treatment for rabid patient = number of patients * cost of treatment by DRG
- Cost of treatment for immunoglobulin side effect = number of patients * cost of treatment by DRG
- Cost of laboratory diagnosis in human

The required data to calculate total cost and cost per unit of the activities are comprised of an output of each activity in every organization in fiscal year 2000, an expenditure in fiscal year 2000. Except for LGA, data are not available then the researcher needs to calculate (or estimate) an output of activity by dividing total cost with average cost. An output of veterinary private clinics is derived from subtraction total output with outputs of other organizations and then calculates total cost by multiplying average cost.

Methods for apportioning and allocating cost

1. Costs were categorized into 4 group: PET, Dog vaccination, Lab diagnosis in animal, Other programs.
2. To identify cost of those activities, since there are several organizations participating, namely, at least 1 or 2 or 3 activities (see figure 3.3). So it is worth analyzing by organization ahead. Total cost and average cost by activity of each organization will be simply computed. Finally we can sum up their average costs of the same activity weighted by owned outputs, by this means, we will obtain cost of each activity at country picture (see figure 3.4).
3. We have to explore the organization's nature of performing, line of command and its responsibility. After that we can design model of administration and management.
4. Interview their job description of organization's staff.
5. Record flow of resources that was utilized and design a model of resource flow.
6. Identify unit of analysis, working process and output (i.e. PET, Dog vaccination, Lab diagnosis in dog, and Other programs).
7. Again, design a model of cost apportioning that will be useful for understanding how to apportion the cost.
8. Cost will be divided into administration and variable cost, identifying both of them.
9. Useful life of equipment is 5 years and of building is 20 years. Straight-line technique will be applied as criteria to depreciate.
10. This research will use stepdown method to allocate cost by adopting working time that was determined by owned organization's staff.
11. Total cost / output = average cost

Figure 3.2 Relationship between rabies control activities and organizations

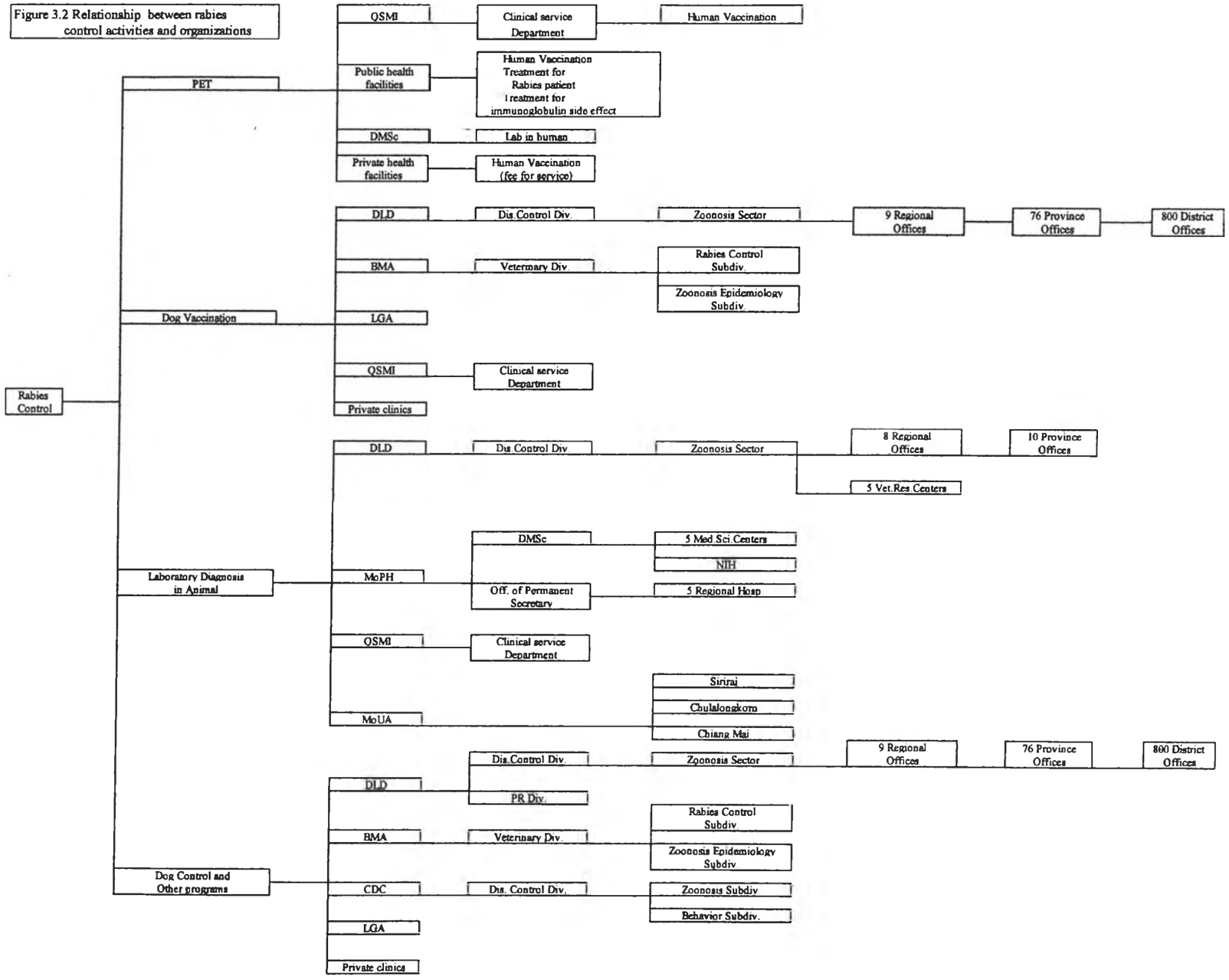
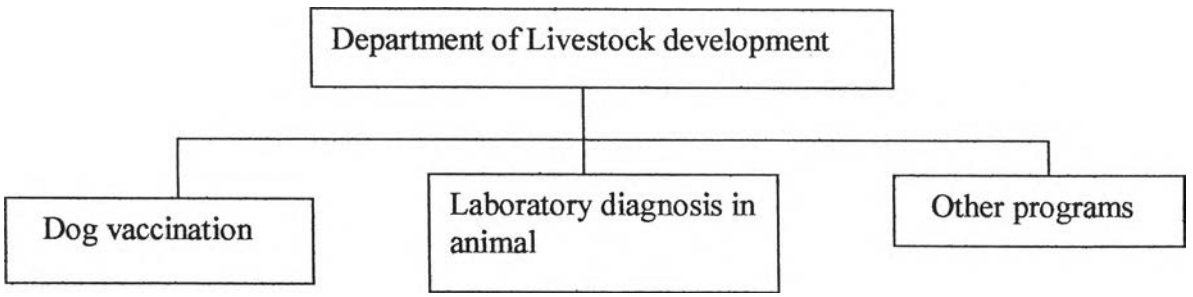
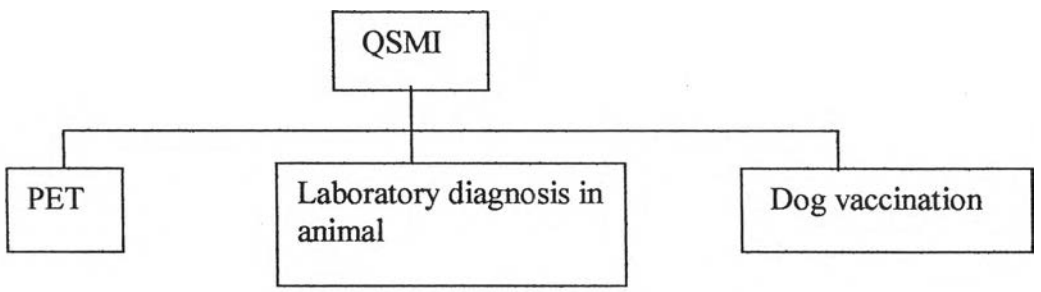


Figure 3.3 Algorithms illustrated organizations that are responsible for Rabies control activities.

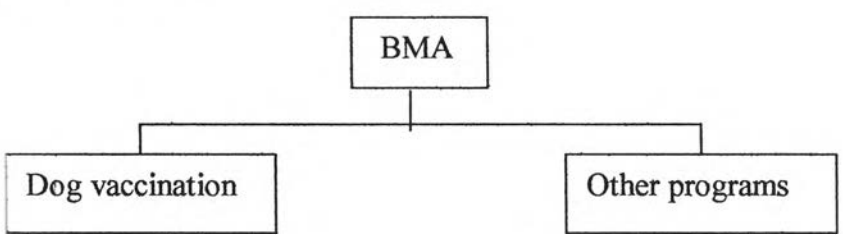
1. Department of livestock development (DLD)



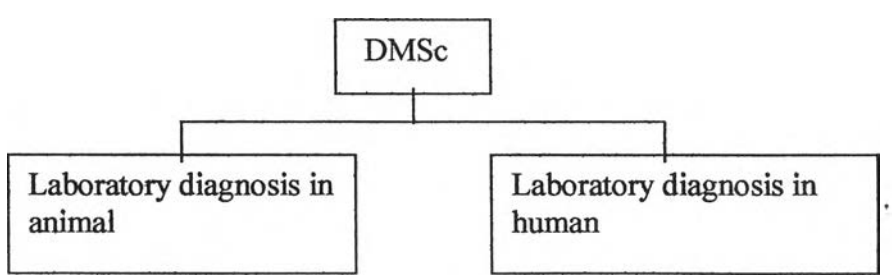
2. The Queen Saovabha Memorial Institute (QSMI)



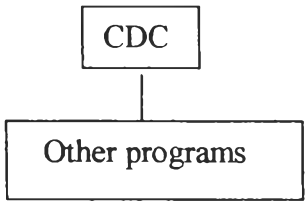
3. Bangkok Metropolitan Authority (BMA)



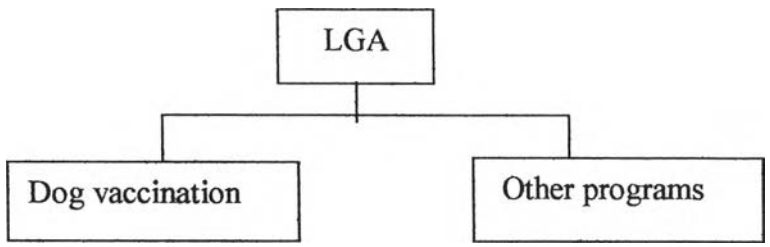
4. Department of medical science (DMSc)



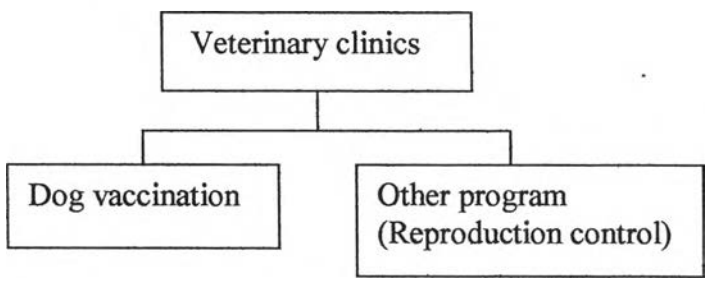
5. Department of communicable disease control (CDC)



6. Local Government Authority (LGA)



7. Veterinary private clinics



8. Public and private health care facilities

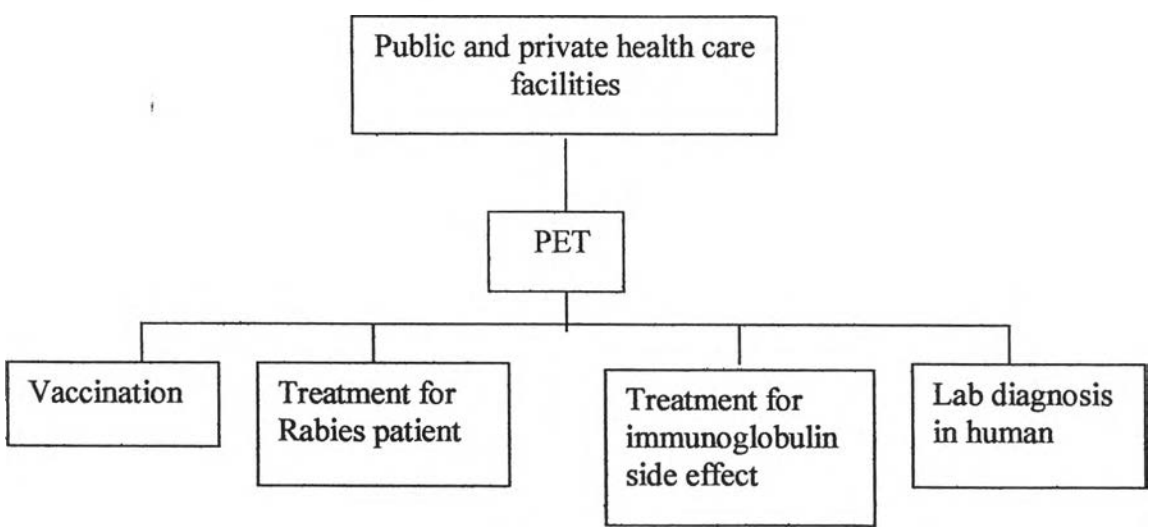
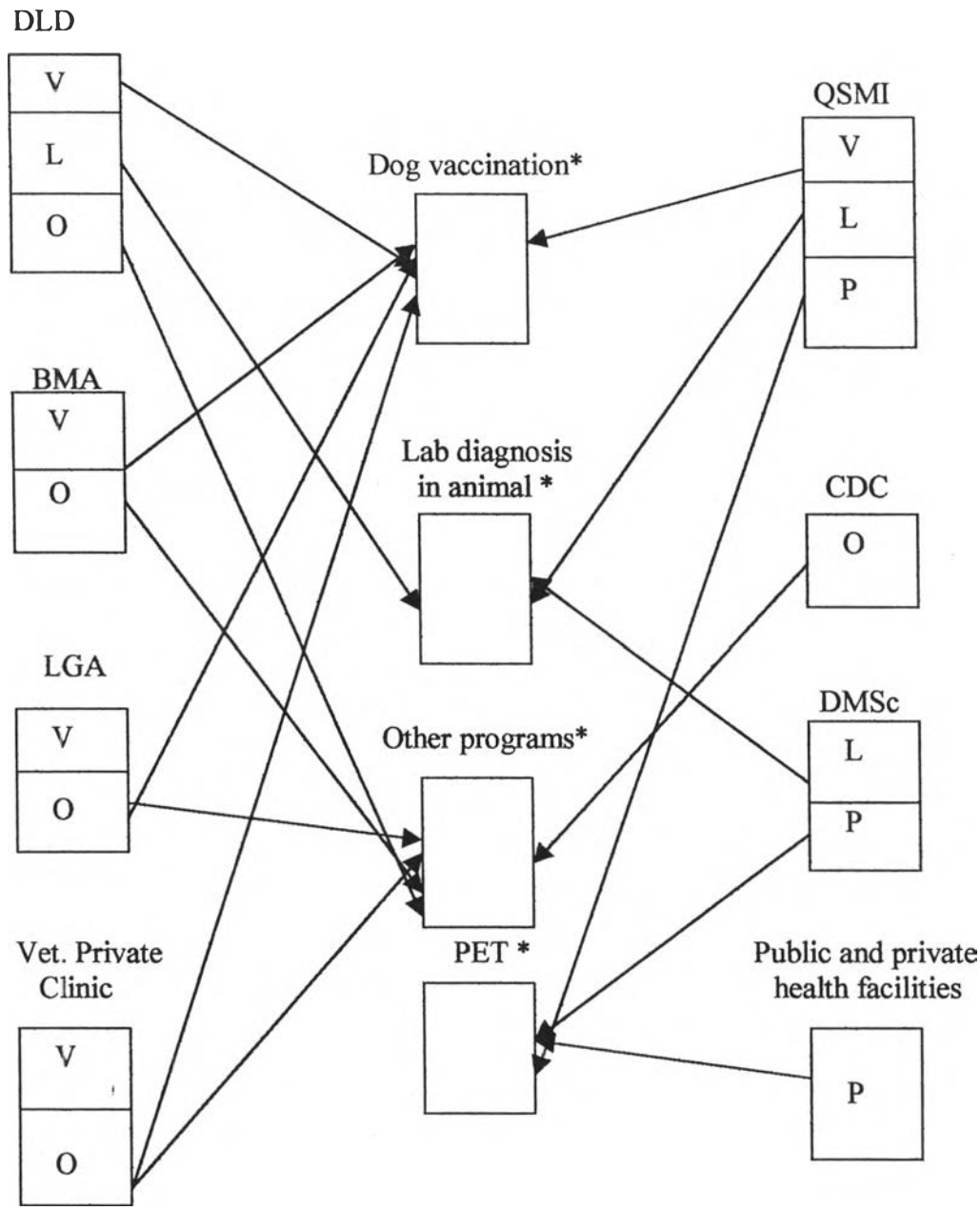


Figure 3.4 Illustrate how costs of rabies control at country level were derived
(V = Dog vaccination, L = Lab diagnosis in animal, O = Other programs,
P = Postexposure treatment)



Note: weighted AC of Dog vaccination *, Lab in animal *, PET * by owned organization's outputs

Method for calculating cost of PET

Since PET is different from dog rabies control, PET should be explained separately.

Assumption;
Costs of Human postexposure treatment (PET) are comprised of PEV cost, cost of treatment for rabies patient, cost of treatment for immunoglobulin side effect, cost of laboratory diagnosis in human.

1. Cost of PEV

1.1 We have to identify a number of vaccinees in year 2000. PEV reported by MOPH is mainly from hospitals supervised by MOPH. Hence total vaccines being imported by pharmaceutical company, which were record their amount and cost by Thai FDA, will be retrieved. This number will be less from MOPH use, and then the rest is the number of vaccines used by other hospitals.

1.2 Types of administering rabies vaccine being practiced nowadays are via intramuscular (IM) or intradermal (ID), detailed in Appendix. For full course of treatment, IM type is required 1 vial per dose then totally 5 vials per course but ID type is consumed only 3 vials per course. ID type is particularly administered by well-trained personal so as to prevent mistaken administering. Usually in practice, a latest study done by Petchaboon Provincial Public Health[21] was found that most of the hospitals use ID type 60% and IM type 40%, but the QSMI; TRC-S, who initiated ID administering, uses ID 70%, IM 30%. To this study, we take both proportions into account of estimate of vaccine utilized.

1.3 When bitten by animal or suspected contracting rabies disease, exposed persons must consume either 5 vials of vaccines (IM) or 3 vials of vaccines (ID); some of them may have gotten immunoglobulin too. From MOPH's PEV reported there is a mix of reports; injected fully 5 visits or in between 1 – 4 visits (suspected dog was justified no rabies and then no need for further vaccine). We will set up a small survey to find out how much proportion is. This proportion will be helpful to calculate a true number of vaccines utilized. Subtracted total imported vaccines (recorded by Thai FDA) from an amount of vaccines being used by MOPH, the answer is the vaccine used by other hospitals, finally taking this answer to calculate a number of vaccinees. Summing number of both groups of vaccinees (IM&ID) is the total number of vaccinees at that year. We also have to find out vaccines consumed by university hospitals, military hospitals, hospitals under BMA and others as possible. The remaining vaccines are served at private hospital.

1.4 Rabies immunoglobulin (RIG) is about 5% of PEV.[28] Costs of RIG will be added.

1.5 Cost per case for exposed person who received treatment from private hospital is a fee in which patient paid to that hospital. We ask this cost from private hospital and discount to value at year 2000 by using consumer price index.

1.6 For public hospital expenditure we use direct material cost of PEV plus labor cost for giving care to an exposed person and discount to value at year 2000 by using consumer price index.

1.7 Total cost of PEV is derived from total number of visits
= {Visits at public hospital (MOPH hospital, University hospital, Military hospital, BMA hospital, other hospital) * Cost per visit at public hospital}
+ (Visits at private hospital * Cost per visit at private hospital)

2. Cost of rabies patient treatment

DRG system can be applied to calculate the cost. Practically in health insurance, it is widely accepted that DRG is a method for calculating cost of any disease. Rabies is also the case. Office of Health Insurance, MOPH has been responsible for analyzing Relative Weight (RW) which is an average cost of treatment in any particular disease comparing to overall diseases.

3. Cost of immunoglobulin side effect treatment

With respect to DRG, this cost is also calculated by the same method as was mentioned in the topic 2.

4. Cost of laboratory diagnosis in human

Not so many investigations were done in order to confirm diagnosis for rabies in the past. On the other hand, confirmation is really necessary for a surveillance system of the disease. Cost of lab diagnosis will be derived from cost analysis of DMSc.

3.3.4 Estimating incremental cost of the intensified-dog control program

After identifying cost of 4 activities in year 2000;
1. Assumption
Current practice (see table 3.1)

- PET = Actual output in 2001, it is 351,141 cases but estimated in 2002-2003 by using average percentage of change during 1991-2001 (assumed ratio of exposed persons who have received care at public and private hospital is not varied during 2001-2003).
- Dog vaccination = Actual output in 2001; 4,579,079 dogs (76.9%), 2002; 3,848,134 dogs (61.1%) but 2003 will be estimated by using average percentage of change during 1991-2002.
- Laboratory in animal = Actual output in 2001; 3,329 specimens, 2002; 2,961 specimens but 2003 will be estimated by using average percentage of change during 1991-2002.
- Costs of other programs are assumed stable.

Table 3.1 Outputs in year 2000-2003

Year	2000	2001	2002	2003
PET [1]	340,394	351,141	NA	NA
Dog vaccination [2]	4,277,939	4,579,079	3,848,134	NA
Dog population [3]	5,987,195	5,953,249	6,298,644	NA
Lab in animal [4]	4,024	3,329	2,961	NA

Note: Actual outputs
Source: 1 CDC, 2-3 DLD, 4 Division of Epidemiology, MOPH

The Intensified-dog control program

- All factors are the same as current practice except for Dog vaccination 80%

2. Taking an average cost (derived from cost analysis in year 2000) of each activity (except other programs) to multiply an output, which is expected to have been occurred in **current practice**. Summing total cost in year 2001-2003.
3. Taking an average cost (derived from cost analysis in year 2000) of each activity (except other programs) to multiply an output, which is expected to have been occurred in **the intensified program**. Summing total cost in year 2001-2003.
4. Total Cost of the intensified program – Total Cost of current practice
   = Incremental cost
   Note: Cost will calculate in year 2000 value.

3.3.5 Estimating incremental benefit of life saved

The intensified-dog control program can prevent death from rabies due to extinction of its reservoir in nature. The number of life saved in this model can be evaluated in term of productivity gained (income foregone). Identifying the proportion of deaths in individual age group[11,14,15] is done so as to calculate income foregone.

There are several approaches to the monetary valuation of health outcomes: (1) human capital; (2) revealed preferences; (3) stated preferences of willingness-to-pay (contingent valuation). Each of these approaches has both practical strengths and weaknesses.

Of this study the researcher adopts *human capital approach.*[18,19,25] The reason[20] is that the utilization of a health care program can be viewed as an investment in a person's human capital. Therefore in measuring the payback on this investment the value of the healthy time produced can be quantified in terms of the person's renewed or increased production in the market place. Hence the human capital method places monetary weights on healthy time using market wage rates and the value of the program is assessed in terms of the present value of future earnings.

Methods for estimating an income foregone

1. Assumption: The intensified program would have been implemented during 2001 – 2003. Then, all value would be discounted to year 2000.
2. Total rabies patients that may have occurred after running the intensified program will be derived by this ways;

- **Current practice**: using an actual number of deaths in year 2001 = 37 deaths, year 2002 = 31 deaths but for year 2003 death will be estimated from rate of death decreasing from year 1981-2002.
- **The intensified program**: from the previous study by Bogel K, et al (1990), they estimated that during the first year of the intensified program a death rate equal to 20% of the initial rate and the incidence was expected to reach zero during the second year. But in this model we assume that the second year still has a report of rabies and the third year is none.

3. The ten-year retrospective data of rabies, 1991-2000, will be explored so as to estimate a proportion of rabies patients in age group in case of the intensified program.
4. Human capital approach [21,29] will be applied in this study because it has largely been used to value changes in the amount of time individuals are able to allocate to paid work as a result of illness or programs to alleviate ill-health.

5. From a formula below

$$\text{Income forgone loss} = \sum_{n=1}^{n=60-y} \frac{I*(1+g)^n}{(1+r)^n}$$

I = average income of Thai people
g = increasing growth rate of income
r = discount rate
y = age of death
n = number of productive year lost due to premature

According to the NSO [30], working age is 15 – 60 years old. Hence year of potential life loss before and after this period will not be taken into account. Income foregone here is calculated based on premature death only but does not account for income loss due to illness because of 100% cases fatality rate and short period of sickness.

6. Parameter I: Using per Capita GDP [31] of that year to calculate.
7. Parameter g: It is referred to economic growth rate; this study uses the average GDP growth during 2000 - 2003.
8. Parameter r: It is referred to discount rate. There are several ways to be acquired, for example, WHO has announced the discount rate at 3%.[32,33] Although previous analyses have utilized various annual discount rates (usually not exceeding 5%), the Panel on Cost-Effectiveness recommends using a 3% discount rate in the "Reference Case" analysis and conducting sensitivity analyses at 0% and 5%.[34] This study will use 3% as a discount rate.

9. Converting year of potential life lost into income foregone. Then we will obtain an economic value in monetary term of life saved.

10. Discounting income foregone in year 2001, 2002, and 2003 to the present value in year2000 and summing up of individual program. After that we subtract income foregone of current practice from the intensified program, the return will be the (incremental) benefit from the intensified program.

3.3.6 Comparison of incremental costs and benefits

Incremental cost and benefit were summarized below.

Situation	Cost (year 2001-2003)	Benefit (year 2001-2003)
Current practice	C1+C2+C3	Y1, Y2, Y3
The intensified program	c1+c2+c3	y1, y2, y3
Incremental Analysis	$(\Sigma C_i - \Sigma c_i)$ ↓	$(\Sigma Y_i - \Sigma y_i)$ ↓
	incremental cost	incremental benefit.

C_i = Cost of rabies control in each year of the current practice
c_i = Cost of rabies control in each year of the intensified program
Y_i = Income foregone of the current practice
y_i = Income foregone of the intensified program

For the following years, when program has been discontinued, the effect of the intensified program has still embedded in community and no death from rabies is the returns.

3.3.7 Sensitivity analysis

The sensitivity of the model will be tested by changing dog population (1:6.72, 1:10, 1:15), discount rate (3%, 5%) and the number of deaths in the intensified program.