CHAPTER 4
EMPIRICAL RESULTS AND DISCUSSION

4.1 Summarization of Policies and strategic plan of rabies control in Thailand, Year 2002 [6]

1. Support local authorities to participate in rabies control

1.1 To prevent their people and animals from contraction of rabies around responsibility areas
1.2 To harmonize governmental policies with local authorities
1.3 To extend areas of canine vaccination coverage

2. Encourage a preventive procedure to manipulate rabies in high risk areas

For several years ago, it has revealed that many areas still had contraction of rabies in humans and animals, scattering across country and repeating epidemic in the same areas. It should be established a capacity building among government institutions and local authorities in order to monitor closely and take action immediately.

3. Develop an effective rabies surveillance system

3.1 Promote laboratory diagnosis in animals and humans in case of confirmation. Data exchange among organizations that have worked on a rabies control so that we can have update data and can carry out an effective operation of controlling immediately.
3.2 Establish a good-cooperation team to control rabies in humans and animals in case of epidemic. By this way a number of contracted cases either human or animal should be suppressed just in time.

4. Extend and stabilize rabies-free area

Establishing campaigns for rabies-free area are to control disease and declare rabies-free areas as WHO and OIE criteria

4.1 Year 2001, there has been a consideration of the plausibility areas that can be set up as rabies-free areas, for example, island zone in 11 provinces.
4.2 Year 2002, it is embarked from a provincial rabies-free area and then extended to the surroundings.

5. Disseminate health education to all specific target group

5.1 In high-risk population, like elementary school children (5 – 9 years of age) should be acknowledged a severity of rabies and the self-care as well as prevention in case of dog bitten.
5.2 Embody an idea of responsibility to dog's owner.

6. Strengthen regulation measures to control rabies

   In order to proceed effectively, related law must be in effect.

6.1 Rabies Act, B.E. 2535: a regulation measure to animal's owners
6.2 Public Health Act, B.E. 2535
6.3 Communicable Disease Act, B.E. 2523
6.4 Criminal law

4.2 Names of Participating Organization and their Role in Rabies Control

1. Department of Disease Control, MOPH

Rabies control activities are undertaken by Zoonosis sector; division of communicable disease. This sector acts as a supporter who has cooperatively worked with DLD, BMA, and LGA via provincial public health office, as well as allocating some of budget to encourage their activities, for example health education, general campaigns. However an important work done by department is to control rabies in community when being notified a new reported case in any community.

2. Department of Medical Science, MOPH

This department is responsible for many laboratory research and investigation and also has outreach laboratory centers locating in 12 regions. Rabies investigation was done by the National Institute of Health and 5 Medical Science Centers (formerly 7 centers in 1998). In addition, they have mostly done a lot of research in development of rabies diagnosis technique.

3. Department of Livestock Development, MOAC

3.1 Disease control division (currently Bureau of Veterinary Disease Control and Prevention)

It is the major responsibility of this division, particularly undertaken by Zoonosis sector. This sector is responsible for policy planning, evaluation program, coordination internal and external organization working for rabies control, and mainly for procurement of budget to livestock local offices (regional, provincial and district). Most of rabies control activities that have to support are dog vaccination program, dog population control program, laboratory diagnosis in animals and health education, for instance.

3.2 National Veterinary Health Institute

This institute has recently been established and responsible for laboratory diagnosis and has had 5 veterinary research centers under supervision since 2002. Previously 5 centers were under Disease Control Division.

3.3 Division of Public Relation

This division disseminated all broadcast campaigns and health education. There has budget supported by Zoonosis sector.

3.4 Livestock local offices (Regional, Provincial, District)

They are actually operational units not only working for rabies control but also for other jobs which have been commanded by other divisions in DLD. Differently by areas, the magnitude of rabies problem is also not the same and certainly its task is dependent on the priority. There have 9 regional offices, 76 provincial offices and approximately 800 district offices across country (but nowadays under the

Bureaucratic Reform Act district offices have been closed and moved to joint with another MOAC local office). However 8 out of 9 regional offices and 10 out of 76 provincial offices have their owned laboratory serving for rabies diagnosis in animal.

4. Queen Saovabha Memorial Institute, the Thai Red Cross Society.

Well – known as a not-for-profit organization that tremendously helps our society treating rabies for a long time. It serves community as a source of postexposure vaccination, laboratory diagnosis in animals and a small amount of dog vaccination but significantly does research in vaccine and immunoglobulin technology.

5. Veterinary Public Health Division, Bangkok Metropolitan Authority.

There are 2 sectors out of 4 responsible directly for rabies control in Bangkok area and collaboration with DLD and MOPH. Major activities are dog vaccination, population control management and health education. Its service has been served through BMA Veterinary Clinic scattering 7 places around Bangkok territory.

6. Local Government Authorities

Similar to BMA's work but virtually playing a significant role a few years ago, it is after the Delegation Act (1999). In effect of this Act 20% of national budget in FY 2000 and 35% in FY 2006 must be allocated to these authorities. However in the beginning they have to work closely with livestock local office. There are around 8,000 LGA in Thailand and some parts of them participating in controlling of rabies at that time.

7. Public and private health facilities

Public and private hospitals are the major organization who provide care to exposed persons either outpatient care or inpatient. Postexposure vaccination is their responsibility.
In addition some university hospitals such as Siriraj hospital, Chulalongkorn hospital and Chiengmai University hospital have provided service for laboratory investigation and research in animal and human too.

8. Veterinary Private Clinics

Approximately 1,000 clinics across country have provided pet vaccination and reproduction control. Almost a half of dog vaccination was done by these clinics.
There are also some faculties of veterinary given services to community but unfortunately in limited extent.

4.3 Empirical Results of Cost Analysis

4.3.1 Empirical results of cost analysis of Dog vaccination, Laboratory diagnosis in animals and other programs

Results of cost analysis were analyzed by organization, starting from its administration structure and responsibility, resource flow and a model of cost allocation and also computation of cost was illustrated in tabular form.

1. Department of livestock development (DLD)

Costs of rabies control by DLD are comprised of 3 activities; (1) dog vaccination (2) laboratory diagnosis in animal (3) other programs (reproduction control, dog destruction, and health education).

Policies and budgets of these activities were assigned by central DLD office. It is undertaken by zoonosis sector; disease control division. DLD local offices are the operational units who execute the policies. Another division, Public Relation division is responsible for health education and dissemination of information about rabies disease.

Disease control division has 6 sectors under supervision. Zoonosis sector is the only one who has responsibility for rabies control approximately 90% of its working time and 10% for other diseases. Criteria for allocating an overhead cost within disease control division are:
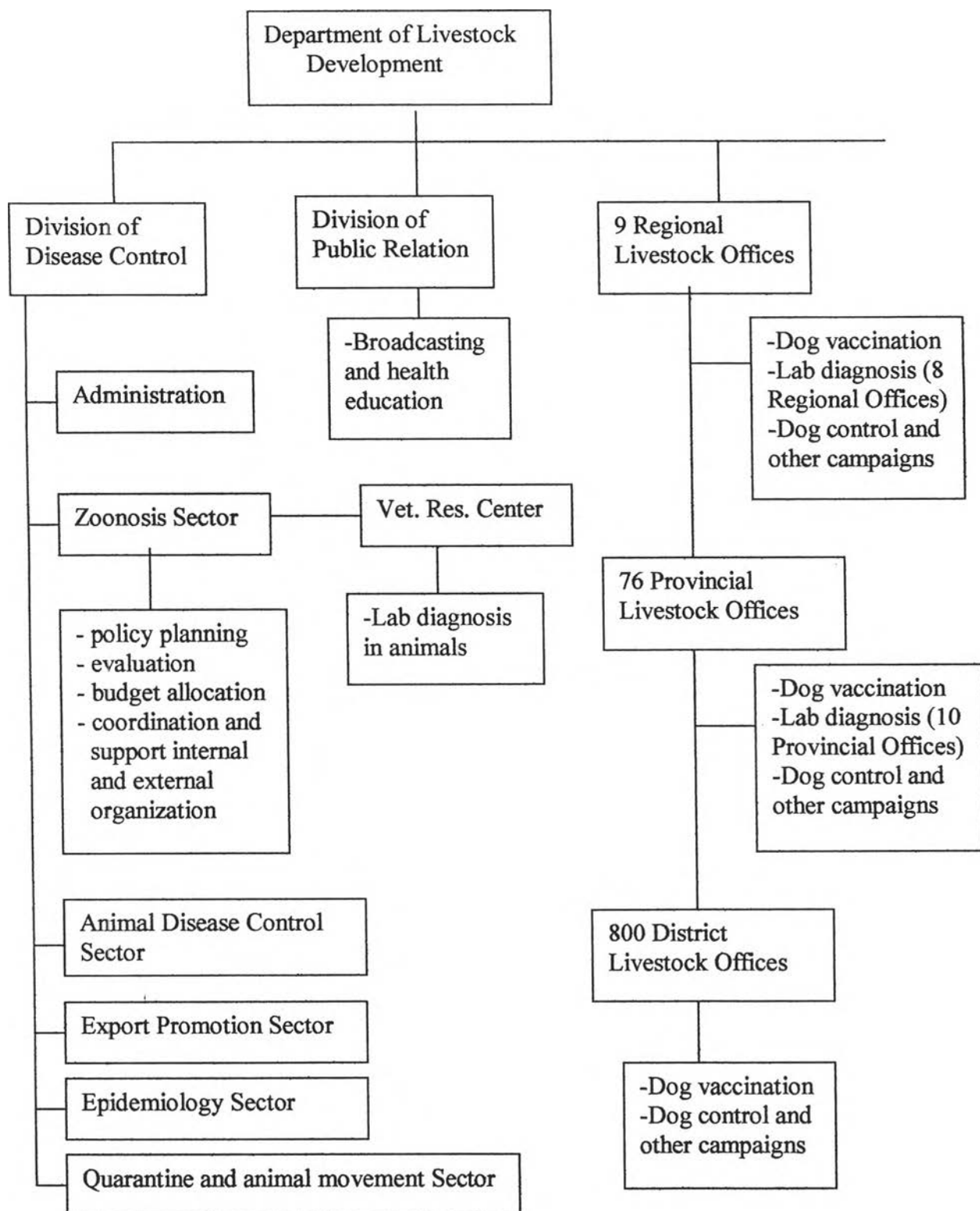(1) Salary of individual sectors,
(2) Floor space of individual sectors for allocating utility expense,
(3) After that the researcher will use budget in which the three activities have directly received as weighted to divide an overhead cost from zoonosis sector.

PR division has spent on working time approximately 20% for health education and dissemination. The researcher will allocate 20% of its expense to the two activities (except lab) by using the same criteria as mentioned above.

By interviewing DLD local office, it was found that rabies control was under the section of animal disease prevention and treatment and consumed 4.5% of working time. The researcher will allocate 4.5% of DLD local office expenses (only salary and capital cost because DLD local office had received material cost directly from zoonosis sector) to dog vaccination activity and other programs, by using individual activity budget directly received as weighted. But for laboratory diagnosis in animals, it is an independently activity because of having own staff.

Analytical results were shown in table 4.1-4.2 and figure 4.1 – 4.3.

Figure 4.1 Model of administration and responsibilities; DLD

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                    │ Department of Livestock │
                    │     Development       │
                    └─────────────────────┘
                               │
        ┌──────────────────────┼──────────────────────────┐
        │                      │                          │
┌───────────────┐    ┌───────────────┐         ┌───────────────┐
│ Division of   │    │ Division of   │         │ 9 Regional    │
│ Disease Control│   │ Public Relation│        │ Livestock Offices│
└───────────────┘    └───────────────┘         └───────────────┘
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- Department of Livestock Development
  - Division of Disease Control
    - Administration
    - Zoonosis Sector — Vet. Res. Center
      - policy planning
      - evaluation
      - budget allocation
      - coordination and support internal and external organization
      - (Vet. Res. Center) -Lab diagnosis in animals
    - Animal Disease Control Sector
    - Export Promotion Sector
    - Epidemiology Sector
    - Quarantine and animal movement Sector
  - Division of Public Relation
    - -Broadcasting and health education
  - 9 Regional Livestock Offices
    - -Dog vaccination
    - -Lab diagnosis (8 Regional Offices)
    - -Dog control and other campaigns
    - 76 Provincial Livestock Offices
      - -Dog vaccination
      - -Lab diagnosis (10 Provincial Offices)
      - -Dog control and other campaigns
      - 800 District Livestock Offices
        - -Dog vaccination
        - -Dog control and other campaigns

Note: This structure was represented in year 2000.

Figure 4.2 Model of resource flow: DLD

Dog vaccination, Dog control and other programs

Division of Public Relation

Division of Disease Control
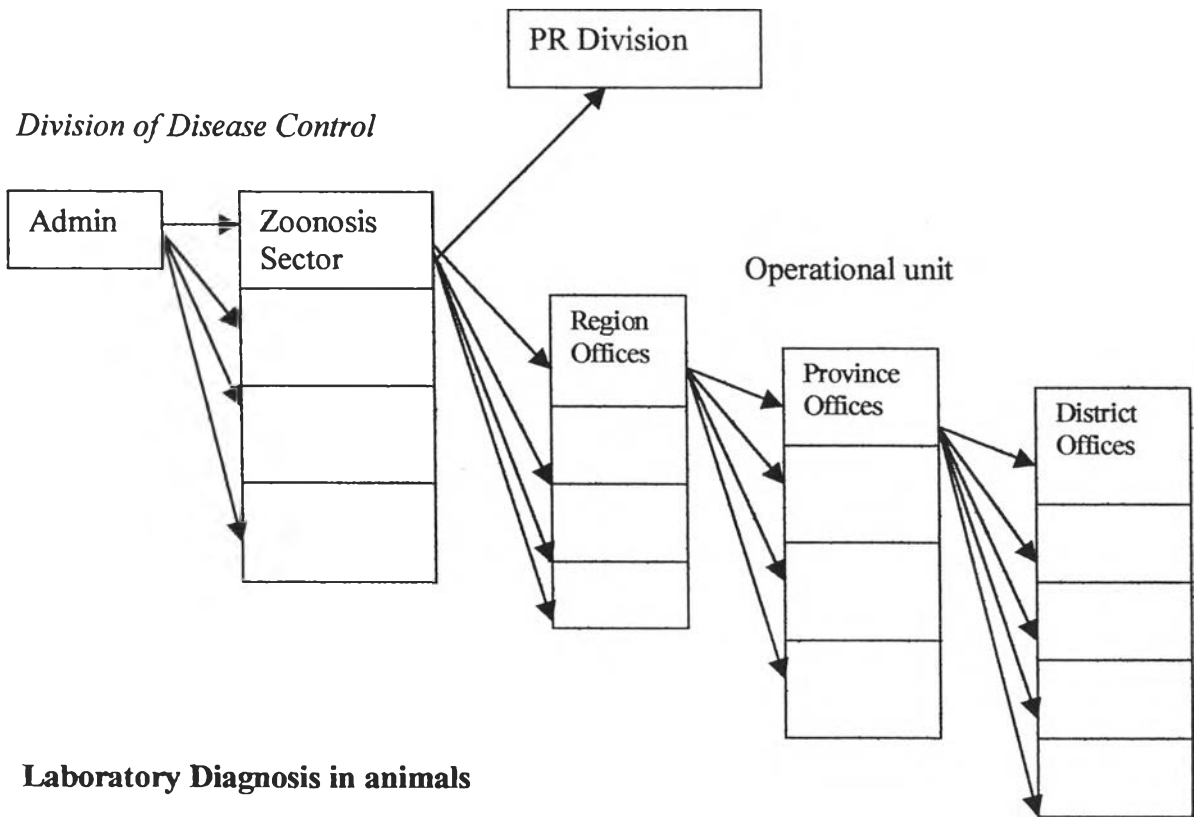
Laboratory Diagnosis in animals

Division of Disease Control   operational unit
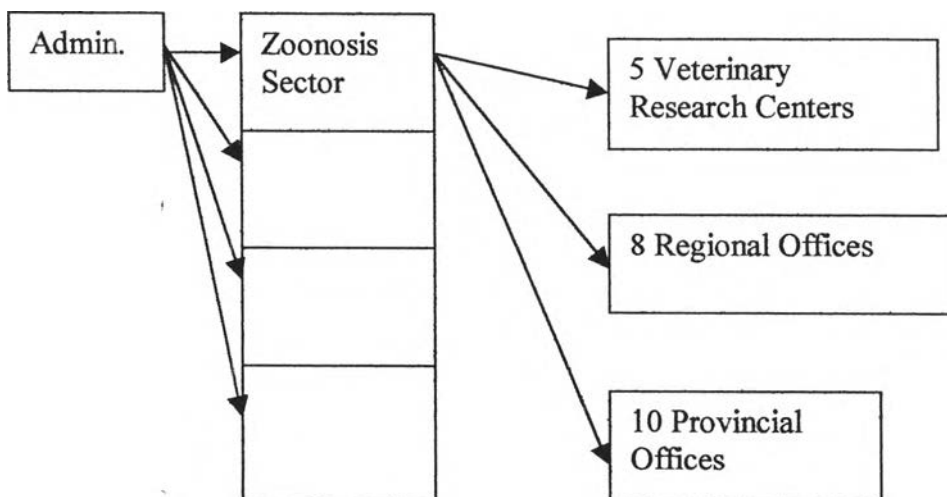
Figure 4.3 Model of cost allocation: DLD

Administration cost

Total cost

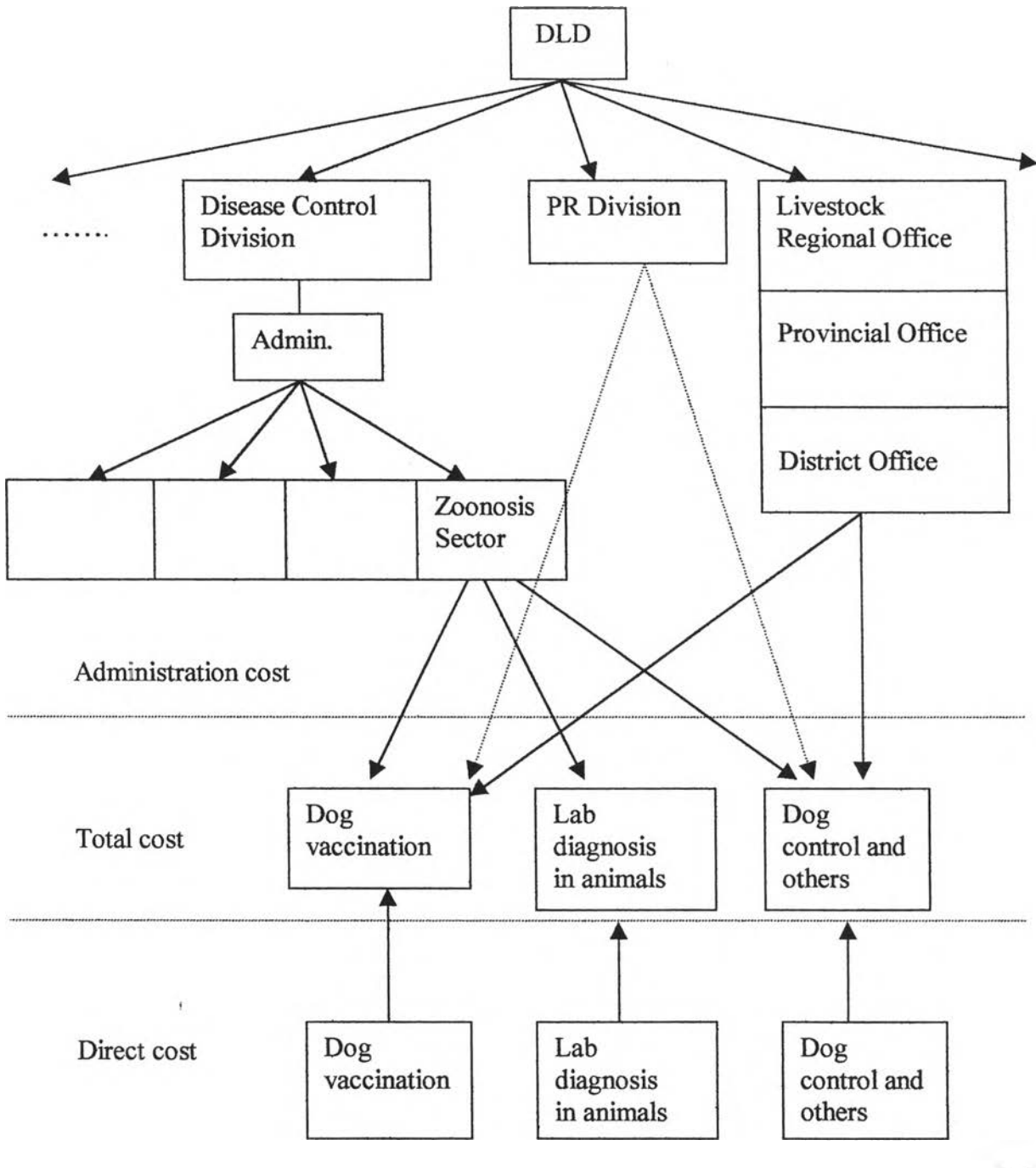Direct cost

Table 4.1 Cost allocation: DLD (Currency: Baht)

Division/Sector	LC	MC	CC	Other	Floor space (sq.m.)	Utilities (%sq.m.)	Admin. (%LC)	Subtotal	Zoonosis sector(%activity expense) #	PR division (%activity expense) # #	Livestock local office (%activity expense)**	Total Administration cost
Utilities*				2,232,800								
Disease Control Div.												
- Administrative	2,623,800				50	558,200						
- Zoonosis Sector	1,676,640	245,000	1,137,960	98,400	50	558,200	154,678	3,870,878	3,483,790			3,483,790
- Other Sector	26,764,260				100	1,116,400	2,469,122	30,349,782				
Subtotal	31,064,700	74,000	2,000,560	2,331,200	200	2,232,800	2,623,800					
Public Relation Div.	2,420,640									484,128		484,128
Livestock local office Region,Province District)**	726,296,994		26,959,860	7,033,400				760,290,254			34,213,061	34,213,061

Note: * Utility expense is only for Disease control division.
   ** Livestock local office salary is only 4.5% allocated to rabies control.
   # Zoonosis sector expense is 90% allocated to rabies control
   # # Public Relation Division salary is only 20% allocated to rabies control.

Table 4.2 Full cost and Unit cost (Currency: Baht)

Activity	Output	LC	MC	CC	Other*	Training**	Subtotal	Administration cost	Zoonosis sector (% activity)***	PR division (% activity)***	DLD local office (% activity)***	Total	Cost / unit
Zoonosis sector								3,483,790					
Public Relation Div.								484,128					
Livestock local office Region,Province District)								34,213,061					
Dog vaccination	1,929,030	6,000,000	42,000,000		673,200	228,000	48,901,200		2,058,140	319,914	22,608,182	73,887,437	38.30
Lab in animals	2,198	7,051,408	858,080	862,600			8,772,088		369,197			9,141,285	4,158.91
Other programs		3,000,000	21,200,000		673,200	228,000	25,101,200		1,056,452	164,214	11,604,879	37,926,745	
Total		16,051,408	64,058,080	862,600	1,346,400.00	456,000.00	82,774,488.00		3,483,790	484,128	34,213,061	120,955,467	

Note: * Other = Transportation and hotel expense spent by DLD local office was allocated to dog vaccination and other program equally.
   ** Volunteer Training was allocated to dog vaccination and other program equally.
   *** Weighted by activity budget directly received except PR division and DLD local offices that were not allocated to lab in animals

Table 4.3 Department of Livestock Development: List of expenditures on rabies control in 2000 (Currency: Baht)

| Expenditure | Disease Control Division | | | Public Relation Division | DLD local office |
	Zoonosis Sector	Administrative sector	Other sector		(Region,Province,District)
Salary					
Salary and Temporary wage	1,676,640.00	2,623,800.00	26,764,260.00	2,420,640.00	726,296,993.65
Project salary (Laboratory staff)	7,051,408.00	-	-	-	-
Total	**8,728,048.00**	**2,623,800.00**	**26,764,260.00**	**2,420,640.00**	**726,296,993.65**
Remuneration and materials					
Overtime (Zoonosis sector)	36,000.00	-	-	-	-
Wage for dog vaccination	6,000,000.00	-	-	-	-
Wage for contraceptive injection	3,000,000.00	-	-	-	-
Transportation and Hotel:					
- DLD central office staff	62,400.00	-	-	-	-
- DLD regional office staff		-	-	-	374,400.00
- DLD provincial and district		-	-	-	972,000.00
Vehicle maintenance	54,000.00	-	-	-	-
Equipment maintenance					
- central office	-	-	-	-	-
- regional lab room	171,000.00	-	-	-	-
Volunteer Training					456,000.00
Stationary	20,000.00	-	-	-	-
Household materials for Lab room	36,000.00	-	-	-	-
Scientific materials for lab 23 lab.		-	-	-	-
30,000 baht per lab	690,000.00				

Expenditure	Disease Control Division			Public Relation Division	DLD local office (Region,Province,District)
	Zoonosis Sector	Administrative sector	Other sector		
Drug:					
- Rabies vaccine	42,000,000.00	-	-	-	-
- Contraceptive	7,000,000.00	-	-	-	-
- Canine sterilization: male	4,000,000.00	-	-	-	-
- Canine sterilization: female	4,000,000.00	-	-	-	-
- Anaesthesia drug	5,700,000.00	-	-	-	-
- Drug for dog destruction	500,000.00	-	-	-	-
Uniform for lab clerk	45,200.00	-	-	-	-
Lab Animal food	86,880.00	-	-	-	-
Total	72,711,480.00	-	-	-	1,802,400.00
Utilities	-	2,232,800.00	-	na	7,033,400.00

Expenditure	Disease Control Division			Public Relation Division	DLD local office (Region,Province,District)
	Zoonosis Sector	Administrative sector	Other sector		
Capital cost					
1. Equipment					
- Received year 1996	**7,043,600.00**	-	-	-	**57,691,700.00**
1.1 Office equipment	247,100.00	n.a.	n.a.	n.a.	4,346,700.00
1.2 Vehicle	455,000.00	n.a.	n.a.	n.a.	52,217,000.00
1.3 Personnel computer	-	n.a.	n.a.	n.a.	1,128,000.00
1.4 Household equipment	354,200.00	n.a.	n.a.	n.a.	-
1.5 Scientific equipment	1,009,300.00	n.a.	n.a.	n.a.	-
-Fluorescense microscope	2,086,000.00				
1.6 Weapon equipment	2,800,000.00	n.a.	n.a.	n.a.	-
1.7 Communication device	92,000.00	n.a.	n.a.	n.a.	-
- Received year 1997	**1,007,700.00**	-	-	-	**35,105,000.00**
1.1 Vehicle	-	n.a.	n.a.	n.a.	35,105,000.00
1.2 Scientific equipment	113,700.00	n.a.	n.a.	n.a.	-
-Fluorescense microscope	894,000.00				
- Received year 1998	**897,000.00**	-	-	-	**1,384,300.00**
1.1 Household equipment	43,500.00	n.a.	n.a.	n.a.	-
1.2 Personnel computer	-	n.a.	n.a.	n.a.	137,000.00
1.3 Advertising equipment	173,500.00	n.a.	n.a.	n.a.	1,247,300.00
1.4 Weapon equipment	680,000.00	n.a.	n.a.	n.a.	
- Received year 1999	-	n.a.	n.a.	n.a.	-

Expenditure	Disease Control Division			Public Relation Division	DLD local office (Region,Province,District)
	Zoonosis Sector	Administrative sector	Other sector		
- Received year 2000	844,500.00	-	-	-	969,550.00
1.1 Office equipment	121,100.00	n.a.	n.a.	n.a.	969,550.00
1.2 Weapon equipment	723,400.00	n.a.	n.a.	n.a.	-
Total	9,792,800.00	n.a.	n.a.	n.a.	95,150,550.00
2. Building					
- Received year 1996 (built lab room	840,000.00	n.a.	n.a.	n.a.	56,120,500.00
- Received year 1997	-	n.a.	n.a.	n.a.	51,095,000.00
- Received year 1998	-	n.a.	n.a.	n.a.	34,440,000.00
- Received year 1999	-	n.a.	n.a.	n.a.	4,880,500.00
- Received year 2000	-	n.a.	n.a.	n.a.	12,059,000.00
Total	840,000.00	n.a.	n.a.	n.a.	158,595,000.00

Capital depreciation per year
1. Equipment (5 years of useful life)
      1.1 Zoonosis sector　= 5,689,800 / 5 =　　　1,137,960.00　per year
      1.2 DLD local office = 95,150,550 / 5 =　　19,030,110.00　per year
      1.3 Scientific equipment and Fluorescense microscope for laboratory room = 4,103,000/5 = 820,600 baht per year
2. Building (20 years of useful life)
      2.1 Zoonosis sector (lab room) = 840,000 / 20　　　42,000.00　per year
      2.2 DLD local office = 158,595,000 / 20 =　　7,929,750.00　per year

2. The Queen Saovabha Memorial Institute (QSMI)

Costs of rabies control by QSMI are comprised of three activities: (1) human PEV (2) Laboratory diagnosis in animals (3) dog vaccination. For dog vaccination is a few output due to very few dogs being vaccinated, so it is not considered in this study.

Among three activities are accounted solely by clinical service department. All expenses analyzed here are derived from whole organization but depreciation of building is not included due to over their useful lifetime (20 years).

Criteria for allocating overhead cost are:
(1) Administration: salary of individual departments.
(2) Utilities: an amount of utilities that were consumed by departments.
(3) Summing and depreciating capital cost, using 5 year of useful lifetime (see table 4.4).
(4) Using an amount of working time as criteria for allocating cost of Clinical Service Department to PEV (85% of total working time) and Laboratory diagnosis in animals (15% of total working time). But dog vaccination is not considered due to very few outputs.
(5) Bringing a result from topic (4) to sum material directly used for PEV and Lab in animal, we will have full cost.
(6) Full cost/output = unit cost (see table 4.5 and 4.6)

Table 4.4 Capital cost, Equipment: QSMI (Baht)

Department	cost #	depreciation *
Admin.	504,781.05	100,956.21
Clinic		
-PEV	14,265.00	2,853.00
-Lab	550,220.50	110,044.10
Other	1,806,936.23	361,387.25

Note: # Incapable to specify type of equipment
* per year

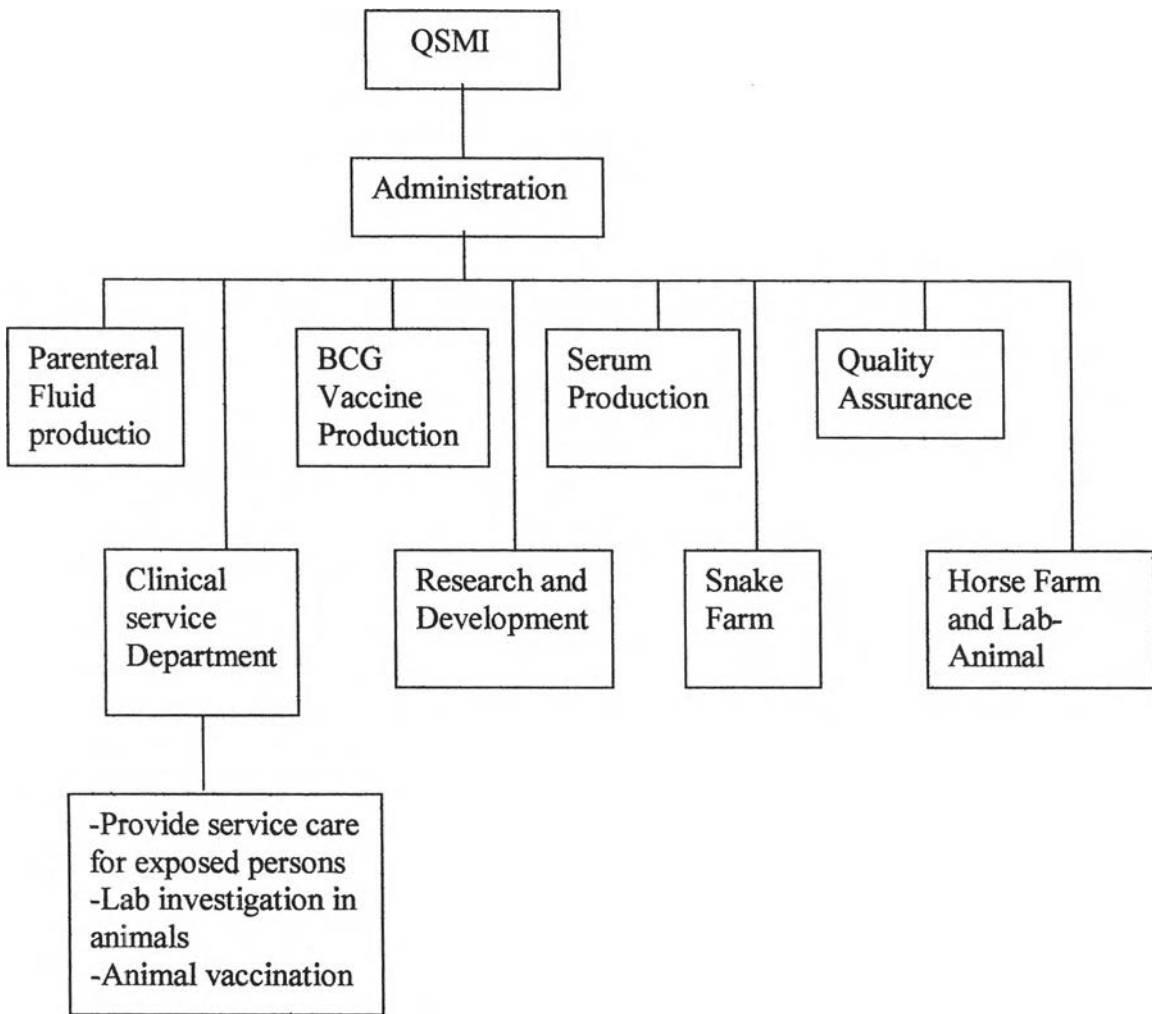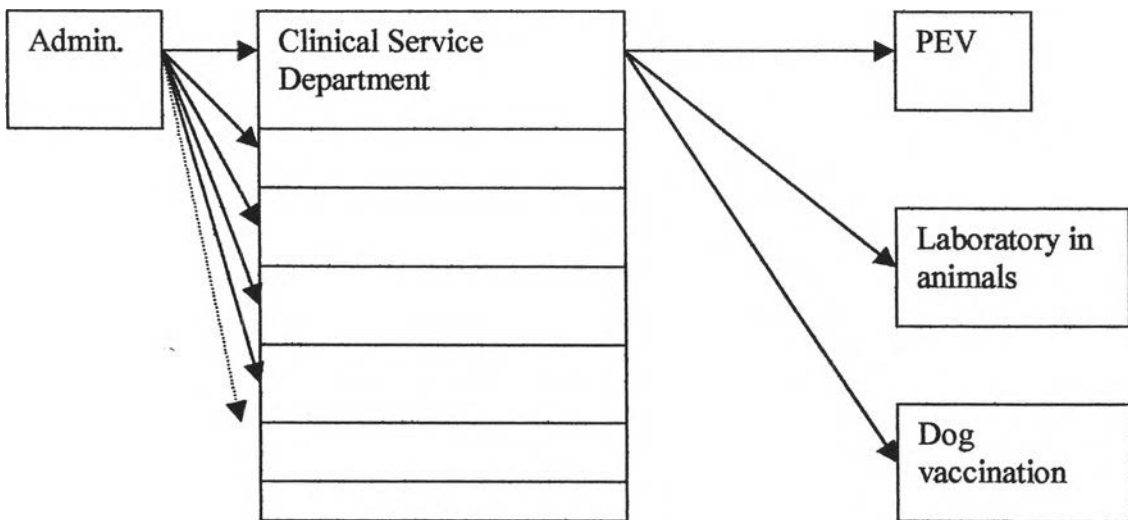Figure 4.4 Model of administration and responsibilities: QSMI

Figure 4.5 Model of resource flow and cost allocation: QSMI

Table 4.5   Cost Allocation: QSMI (Currency: Baht)

Department	LC	MC	CC	Other	Subtotal	%Utility consumed	Utility expense (% consumed)	Administrative (%LC)	Total Administration cost
Utilities				3,511,047.62	3,511,047.62				
Administrative	6,584,882.66	4,341,406.17	100,956.21		11,027,245.04	8.00	280,883.81		
Clinic Service									
-PEV(85%LC)	3,765,779.93	641,032.60	2,853.00		4,409,665.53	4.00	140,441.90	1,745,037.85	6,295,145.28
-Lab(15%LC)	664,549.40	394,504.89	110,044.10		1,169,098.39	4.00	140,441.90	307,947.86	1,617,488.15
Other Department	19,972,536.60	22,167,487.65	361,387.25		42,501,411.50	84.00	2,949,280.00	9,255,143.14	54,705,834.65
Subtotal	30,987,748.59	27,544,431.31	575,240.56				3,511,047.62	11,308,128.85	

Note: MC did not include material directly used by PEV and Lab in animal

Table 4.6   Full cost and Unit cost (Currency: Baht)

Activity	Output (visits) #	Administration cost	Vaccine	HRIG&ERIG *	Other	Animal Food	Total	Cost / unit	Cost/full course **
-PEV	18042	6,295,145.28	1,935,880	3,154,080.20	11,852.83		11,396,958.31	631.69	3,158.45
-Lab in animal***	1215	1,617,488.15			8,560.00	32,785.00	1,658,833.15	1,365.29	

Note: # a number of visits = Pre-exposure 607 cases multiply by 3 visits/case = 1,821 visits, Postexposure 2,541 cases multiply by 5 visits/case = 12,705 visits and
Booster (previously immunized) 1,758 cases multiply by 2 visits/case = 3,516 visits
* Use ERIG 4,505 vials: 400 Baht/vial, HRIG 831 vials: 4,814.20 Baht/vial (We include only 231 vials because 600 vials of HRIG are derived from exchanging
Rabies vaccine 1,000 vials (240,000 Baht) under its agreement with National Blood Bank; TRC-S.
** Full cost for Postexposure vaccination = 5 visits (not separated either ID or IM)
*** The number of lab specimens in detail is: dog = 922 specimens, cat 234 specimens and other animals 59 specimens. Then cost of lab diagnosis in dog =
922 * 1,365.29 = 1,258,797.38 baht.

Table 4.7 The Queen Saovabha Memorial Institute: List of expenditures in 2000 (Currency Baht)

Expenditure (Baht)	Pharmaceuticals		BCG vaccine production	Clinical service		Quality Assurance		Research and Development	Horse farm and Lab animal breeding	Serum production	Administrative	shared resources
	Pharmaceuticals	Parenteral fluid		Clinic	Lab	QA	Snake farm					
Salary												
Salary	4,413,707.10		1,670,445.16	4,430,329.33		3,404,360		1,573,695	7,307,650.67	1,602,678.67	5,632,962.66	
Temporary wage									295,200.00		951,920.00	
subtotal	4,413,707.10		1,670,445.16	4,430,329.33		3,404,360		1,573,695	7,602,850.67	1,602,678.67	6,584,882.66	
Remuneration and materials												
Overtime	140.00	27,440.00	52,520.00	107,440.00	169,160.00	101,460.00	160,600.00	4,000.00	1,607,810.00	253,400.00	55,220.00	
Remuneration	175,000.00		20,000.00	460,000.00		370,000.00	84,000.00		250,000.00	120,000.00	859,000.00	
Office maintenance		142,016.80	60,742.83		92,608.50	22,986.53	250,377.58	1,280.00	76,202.00		306,439.10	3,469.20
Equipment maintenance	11,823.40	39,742.68	37,405.30		22,766.80	14,760.79	3,185.70	6,517.50	25,758.33		100,350.66	360.00
Vehicle maintenance									243,950.07		81,844.50	
Medical euipment maintenance		811,750.11	279,112.01		66,323.95	179,546.00		267,949.10	3,381.10	157,971.00		300,000.00
Laundry												36,995.00
News paper and journal				28,500.00		25.00						23,375.57
Stationary	355.00	49,500.00	14,275.00				29,000.00	700.00		23,109.00	114,812.00	
Guest visit									1,374.00			53,565.50
Transportation and hotel; in bound	150.00	594.00	5,060.00	10,070.00		2,540.00		24,021.00	32,650.00	1,050.00	22,970.00	
Transportation and hotel; abroad												
Air conditioning maintenance		26,754.28	13,900.09	4,550.00	31,200.00	42,889.64	10,050.00	58,300.00	1,264.70	6,527.00	14,564.27	1,351.01
Gadget	51,041.57	123,051.44	93,760.07	3,216.20	4,010.44	54,333.20	48,824.00	87,812.19	181,817.36	49,147.36	444,481.93	353,124.17
Cleaning		92,507.40										
Drug	496,324.40	4,517,493.02	2,147,617.80	111,852.83	8,560.00	74,985.79		337,184.92	287,133.50	973,750.60		315,302.58
Uniform		34,400.00	11,280.00	23,190.00		17,860.00	6,020.00	11,440.00	70,495.00	11,400.00	32,120.00	
Food for lab animal					32,785.00	87,822.00	30,550.00		3,774,518.00		14,231.00	
Electric equipment		36,875.16	2,338.58	142.40	4,280.00	800.00	3,419.72		20,693.43	567.00	90,001.10	14,789.04
Water supply equipment		6,024.11	34,880.85	500.00	836.20	481.50	992.96	310.30	22,867.43	1,317.28	29,377.24	13,556.90
Fuel		575,345.34	520.00		2,600.00	595.00			362,949.94		438,046.88	
Membrane filter		174,827.30							3,210.00	190,353.00		
Other materials	407.00	36,269.79	14,507.45	3,424.00	719.00	20,903.10	7,687.30	9,746.00	22,289.86	735.00	64,417.40	19,967.00
Rabies vaccines for the poor				51,880.00								476,751.24
Guard security												
Rabies vaccines for producing Rabies Immunoglobulin				240,000.00								
Vehicle Insurrance									72,913.04		60,922.88	
Animal purchasing						168,805.00						
Ampular glasses		494,337.86										
subtotal	735,241.37	7,188,929.29	2,787,919.98	1,044,765.43	435,849.89	1,160,793.55	634,707.26	809,261.01	7,061,277.76	1,789,327.24	2,728,798.96	1,612,607.21

Expenditure	Pharmaceuticals		BCG vaccine production	Clinical service		Quality Assurance		Research and Development	Horse farm and Lab animal breeding	Serum production	Administrative	shared resources
	Pharmaceuticals	Parenteral fluid		Clinic	Lab	QA	Snake farm					
Utilities												
Electricity									667,885.50		2,671,061.25	
Water supply									410.35		659,533.17	
Telephone									10,530.41		162,261.45	
Mail											18,191.75	
subtotal									678,826.26		3,511,047.62	
Capital cost												
Other equipments	5,284.00	80,612.80	8,881.00	58,305.50		40,334.00		998.99	221,988.49	17,399.83	118,810.65	
Air conditioning					59,500.00							
Scientific and medical equipment	157,120.00	117,470.58	5,384.24	491,915.00	543,021.79		122,338.90	46,797.45	390,619.40			
Equipment for lab animal					3,450.00							
Personnel computer											385,970.40	
subtotal	162,404.00	198,083.38	14,265.24	550,220.50	605,971.79	40,334.00		123,337.89	268,785.94	408,019.23	504,781.05	
Research budget					139,545.55			181,237.75				
Grand Total	5,148,948.47	7,351,333.29	4,656,448.52	5,489,360.00	986,070.39	5,310,670.89	675,041.26	2,687,531.65	15,611,740.63	3,800,025.14	13,329,510.29	1,612,607.21

3. Bangkok Metropolitan Authority (BMA)

Costs of rabies control are comprised of two activities; (1) Dog vaccination (2) other programs (e.g. reproduction control, dog destruction, and health education).

These activities are accounted by division of veterinary public health, which has two subdivisions to undertake; (1) rabies control subdivision (2) zoonosis epidemiology subdivision. Fortunately salary, wage, remuneration, material used, utilities which were spent on rabies control activities had already been refined by the head of division which one to be related to rabies control and also given weight of two activities; dog vaccination 50%, others 50%. All buildings and equipment are over their useful lifetime then not being included in account. Results of computation were explained in table 4.8 and figure 4.6-4.7.

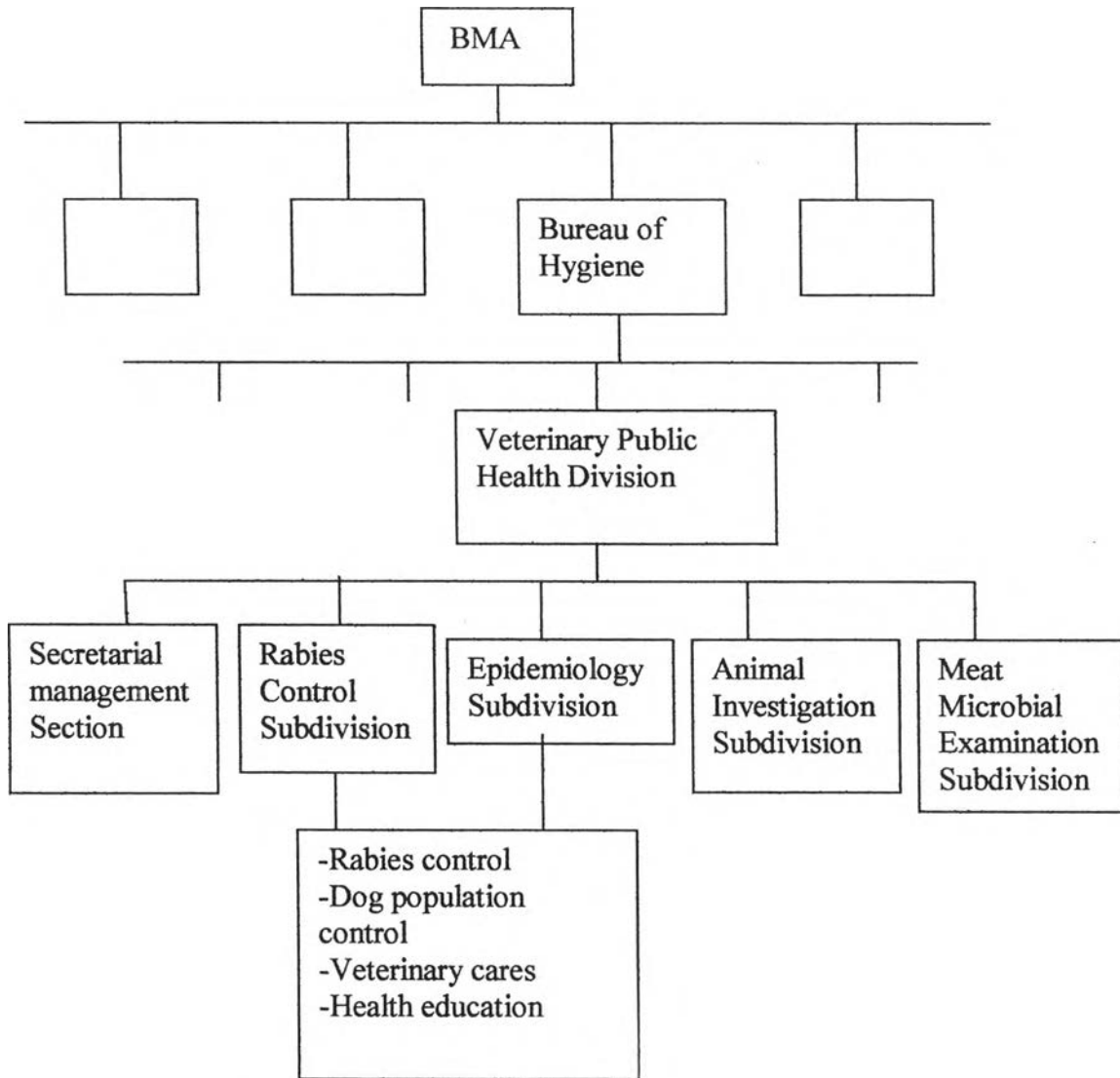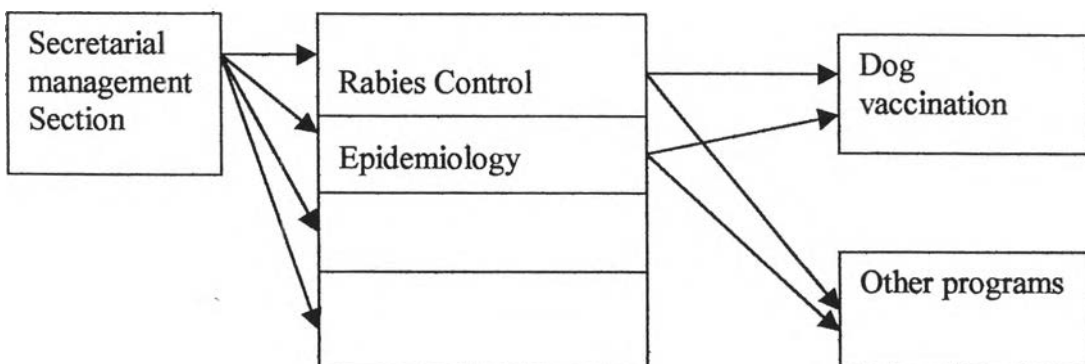Figure 4.6 Model of administration and responsibilities: BMA

Figure 4.7 Model of resource and cost allocation: BMA

Table 4.8 Cost analysis and allocation: BMA (Curency: Baht)

Department	Output (dog)	LC	MC	CC	Vaccine	Other	Subtotal	% working time	Administration (%working time)	Total	Cost/unit
Secretarial Section				n.a.							
Rabies Control											
Subdivision		14,646,255	2,419,488	n.a.			17,065,743				
Epidemiology											
Subdivision				n.a.							
Animal vaccinatio	146,246	600,000		-	4,420,673		5,020,673	50.00	8,532,871.50	13,553,544.50	92.68
Other programs		153,376	71,898	-		2,807,015	3,032,289	50.00	8,532,871.50	11,565,160.50	

Note: The number of animal vaccination in detail is: dog vaccination = 109,275

cat vaccination = 35,882

other animal = 1,089

total 146,246

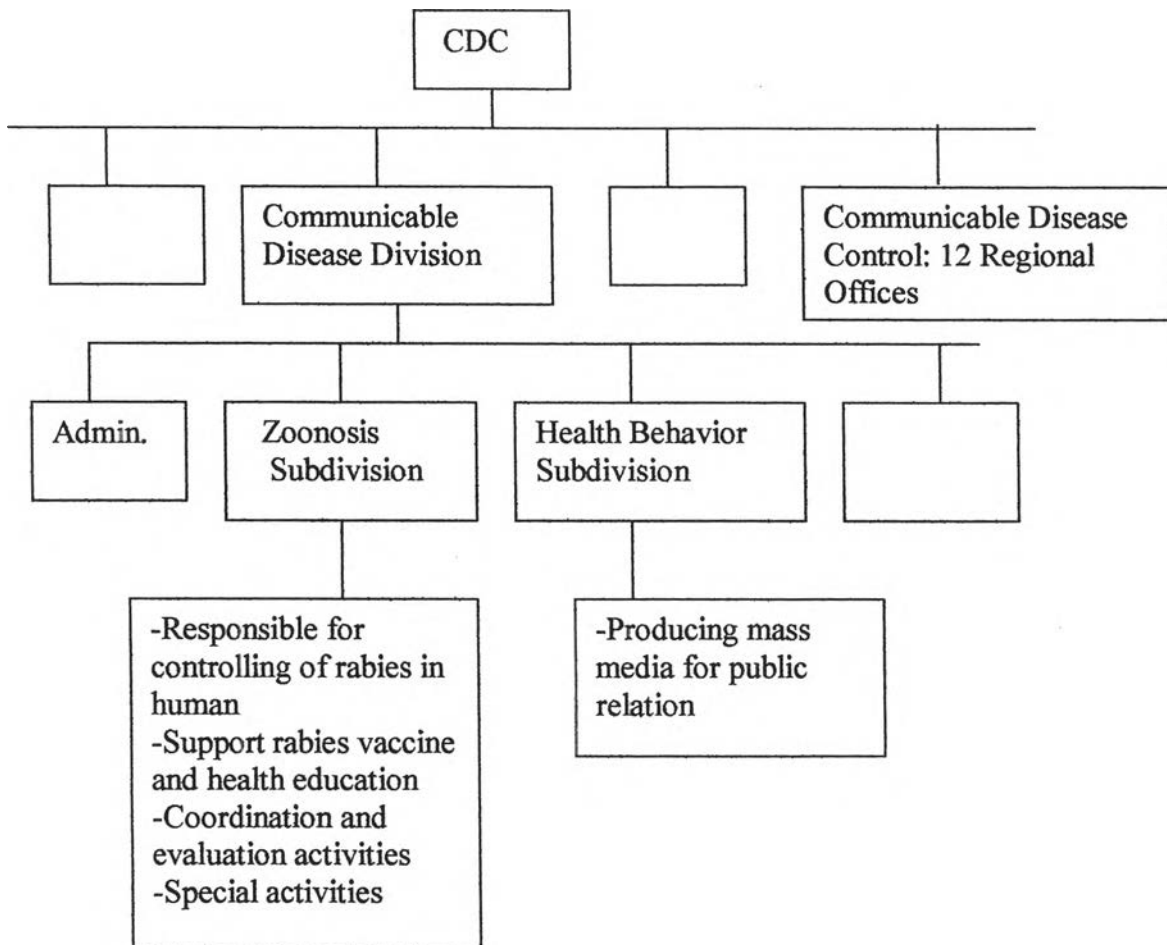Then total cost of dog vaccination solely is 92.68 * 109,275 = 10,127,607 baht

Table 4.9 Bangkok Metropolitan Authority: List of expenditures in 2000
(Currency: Baht)

Expenditure	(Baht)
Salary	
Salary	11,565,890.00
Temporary wage	1,162,765.00
Project salary	1,917,600.00
Total	14,646,255.00
Remuneration and materials	
Overtime	600,000.00
Reward for dog capture	153,376.00
Office maintenance	71,898.00
Vehicle maintenance	349,643.00
Social security fund	37,000.00
Stationary	50,000.00
Photocopies	8,000.00
Vehicle autoparts	100,000.00
Fuel	700,000.00
Uniform	120,000.00
Other materials	600,000.00
Public relation materials	80,000.00
Veterinary material and drug	2,300,000.00
Rabies vaccine for animal	4,420,673.00
Contraceptive drug	191,520.00
Food for animal	112,560.00
Deodorant	35,200.00
Equipment for dog capture	167,735.00
Total	10,097,605.00
Utilities	
Water supply	170,827.00
Electricity	166,245.00
Telephone	74,773.00
Total	411,845.00
Grand Total	**25,155,705.00**

4. **Department of Communicable Disease Control (CDC)**

Costs of rabies control by CDC are comprised of two main activities; (1) prevention and control of rabies in human (2) control of rabies in animal (i.e. dog). In this scope, it is control of rabies in animal to be considered. There are two subdivisions to be responsible; (1) Zoonosis (2) Health Behavior. Zoonosis subdivision is responsible for allocating budget to 12 CDC regional offices and 75 provincial public health offices so as to support rabies control activities in those areas. The researcher did not take labor cost of CDC regional staff and provincial public health staff into account owing to rabies control budgets will be directly spent on animal rabies control campaign working with livestock local office at the same area. Analytical results were illustrated in table 4.10 and figure 4.8 – 4.10.

Figure 4.8 Model of administration and responsibilities: CDC

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                        ┌──────────┐
                        │   CDC    │
                        └────┬─────┘
        ┌────────────────────┼────────────────────────────┐
   ┌────────┐  ┌──────────────┐  ┌────────┐  ┌──────────────────────┐
   │        │  │ Communicable │  │        │  │ Communicable Disease │
   │        │  │ Disease      │  │        │  │ Control: 12 Regional │
   │        │  │ Division     │  │        │  │ Offices              │
   └────────┘  └──────┬───────┘  └────────┘  └──────────────────────┘
        ┌─────────────┼──────────────────────┬─────────────┐
   ┌────────┐  ┌──────────────┐  ┌──────────────────┐  ┌────────┐
   │ Admin. │  │ Zoonosis     │  │ Health Behavior  │  │        │
   │        │  │ Subdivision  │  │ Subdivision      │  │        │
   └────────┘  └──────┬───────┘  └────────┬─────────┘  └────────┘
                      │                   │
   ┌──────────────────────────┐  ┌──────────────────┐
   │ -Responsible for         │  │ -Producing mass  │
   │ controlling of rabies in │  │ media for public │
   │ human                    │  │ relation         │
   │ -Support rabies vaccine  │  │                  │
   │ and health education     │  └──────────────────┘
   │ -Coordination and        │
   │ evaluation activities    │
   │ -Special activities      │
   └──────────────────────────┘
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Note: This structure was represented in year 2000.

Figure 4.9 Model of resource flow: CDC
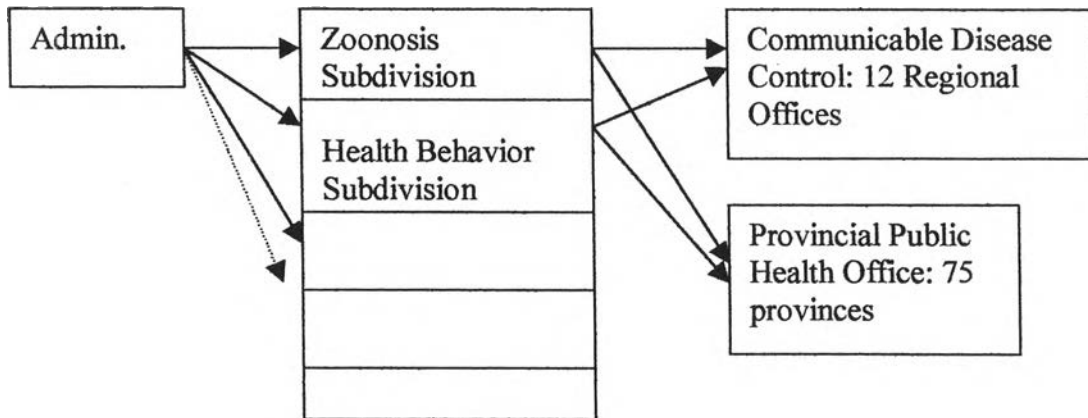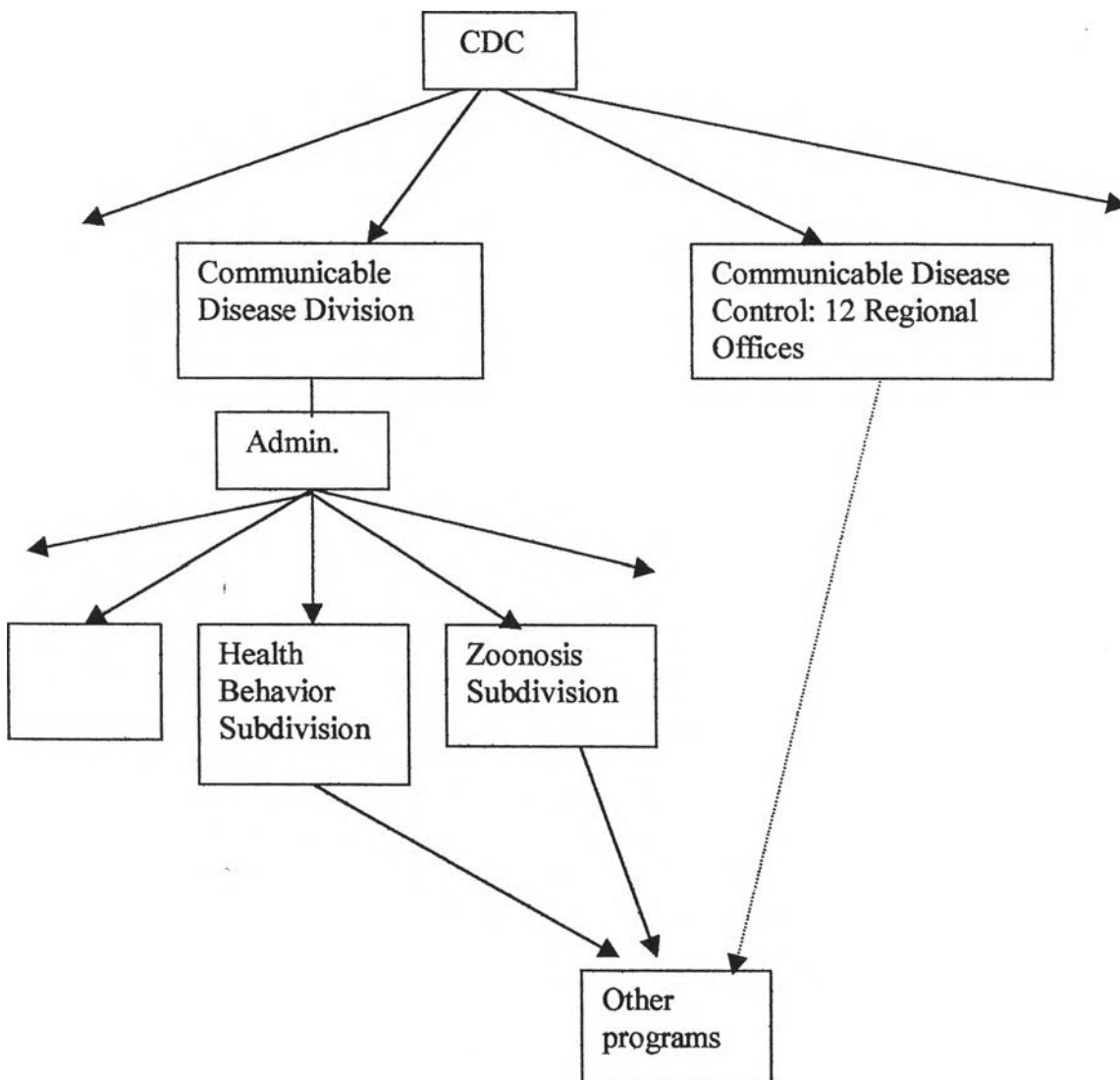
Communicable Disease Division

Figure 4.10 Model of cost allocation: CDC

Table 4.10 Cost analysis and allocation: CDC (Currency: Baht)

Subdivision	LC	MC*	Training &Conferrence	CC	Subtotal	%working time	Zoonosis (%working)	Behavior (%working)	Total
Zoonosis	1,839,600	3,000,000	1,000,000	-	5,839,600	75.00			
Health Behavoir #	3,044,760			-	3,044,760	25.00			
Other program							4,379,700	761,190	5,140,890

Note: Inable to obtain Capital Cost
  # Subdivision of Health Behavior received Material cost from Zoonosis.
  * It was included budget that had allocated to 12 CDC regional offices; 50,000 baht per region and 75 provincial public health offices; 20,000 baht per province.

Table 4.11 Department of Communicable Disease Control: List of expenditure in 2000 (Currency: Baht)

Expenditure (Baht)	Zoonosis	Health behavior
Salary	1,839,600	3,044,760
Budget for rabies control projects*	3,000,000	
Training&Conferrenc	1,000,000	
Total	**5,839,600**	**3,044,760**

Note: * Not include rabies vaccine and rabies immunoglobulin
        Not include outbreak control in community

5. Department of Medical Science (DMSc)

Department of Medical Science is responsible for service, research and technology development to diagnose various diseases. There also have 12 medical science centers across country but only 5 centers have been providing services for rabies diagnosis. At the main center, NIH, this service is undertaken by section of nervous and circulatory system virus; subdivision of medical virology. Previously in year2000 unit cost of service had been analyzed by NIH and shown in table 4.12 and table 4.13.

Generally process to diagnose rabies in animal is started from Fluorescent Antibody technique (FAT) (see details in Appendix) and then reported the findings. With exception to NIH lab it would investigate more in case of unreliable findings by using Mouse Inoculation test (MIT) or Cell Isolation and also receive suspected specimens from other labs to investigate further. Human diagnosis for rabies is usually detected by Polymerase Chain Reaction (PCR).

FAT done by 5 Medical Science centers was assumed the same cost as done by NIH. Laboratory diagnosis or FAT totally done by NIH and 5 Medical Science centers is 611 specimens. Less an output done by NIH are 52 specimens then it is 559 specimens by other centers. Conclusion was shown in table 4.12.

Table 4.12 Unit cost of service and total cost at NIH and 5 Medical
Science Centers

Service List	Output (NIH)	Cost per Sample done by NIH				Total cost (NIH)	Output (Others)	Total cost (others)
		Labor cost	Material cost	Capital cost	Subtotal			
1. FAT	52	325.20	100	807.08	1,232.28	64,078.56	559	688,844.52
2.Cell Isolation	25	325.20	1,630	807.08	2,762.28	69,057.00	0	0
3. MIT	25	325.20	400	807.08	1,532.28	38,307.00	0	0
4. PCR	7	325.20	400	807.08	1,532.28	10,725.96	0	0

Note: Others = 5 Medical Science Centers
Source: Section of nervous and circulatory system virus; NIH, analyzed in 2000

Total cost of laboratory diagnosis in animal
= FAT + Cell isolation + MIT
= (64,078.56+688,844.52) + 69,057 + 38,307
= 860,287.08 baht or
Average cost = 860,287.08 / 611 = 1,408 baht / specimen

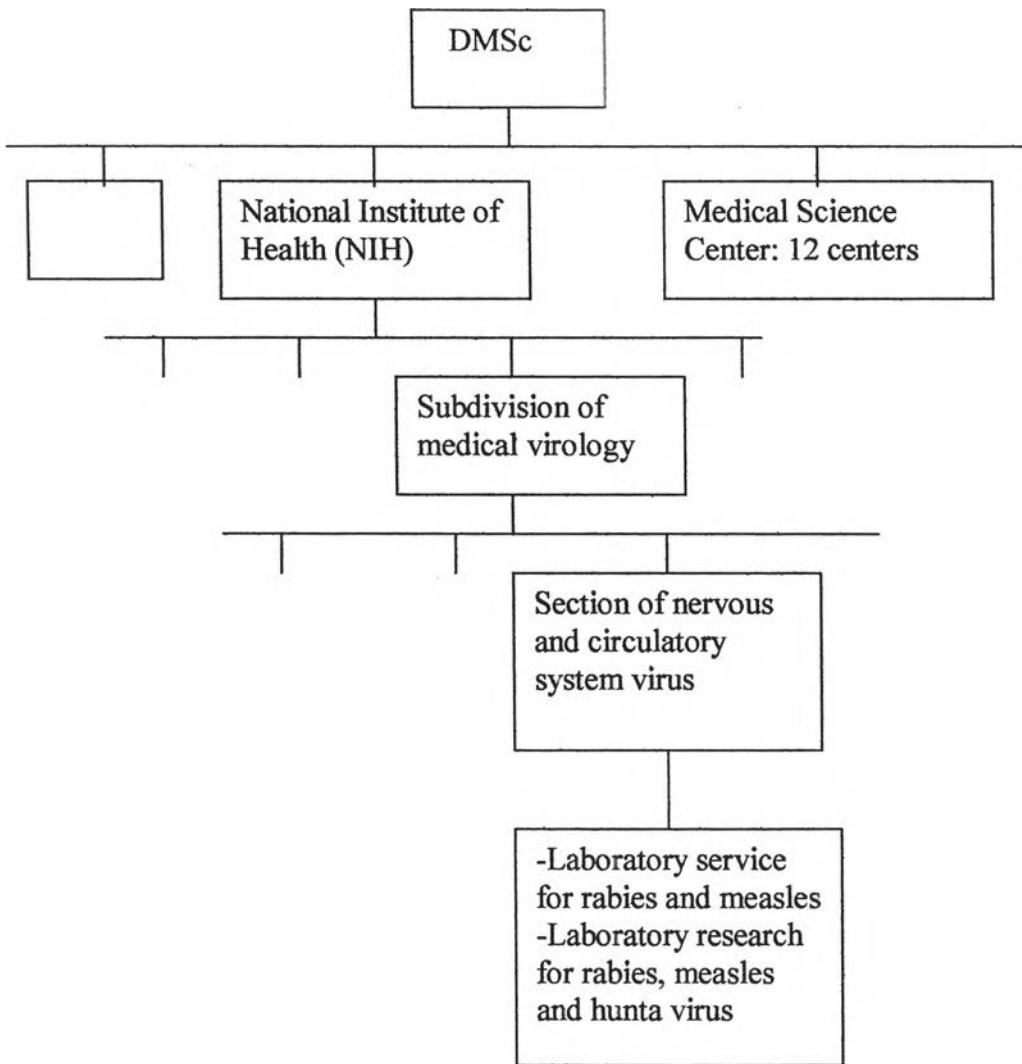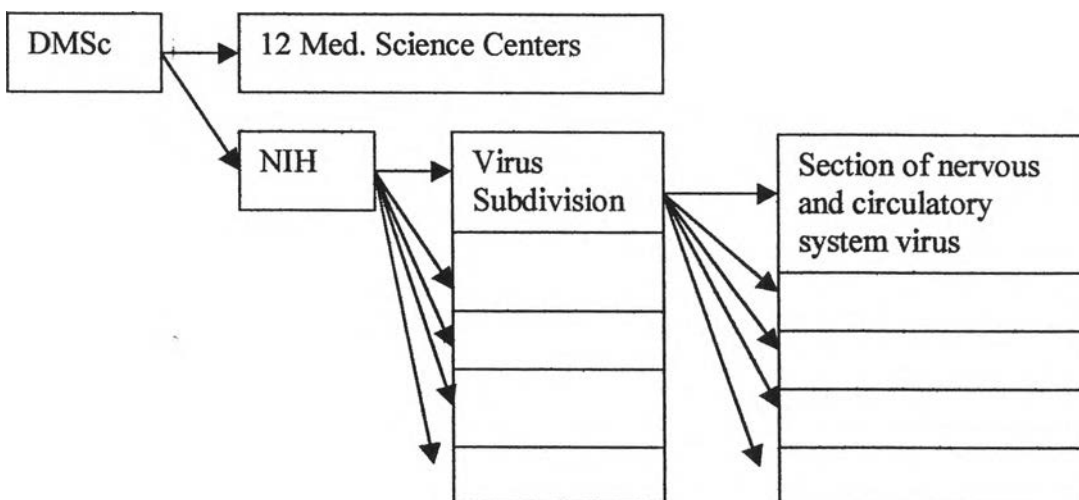Figure 4.11 Model of administration and responsibilities: DMSc

Figure 4.12 Model of resource flow: DMSc

Table 4.13 Section of nervous and circulatory system virus; National Institute of Health: Cost analysis in year 2000

Service List	Cost per Sample done by NIH					Test
	LC	MC	CC (equipment)	CC (building)	Total	
1. Fluorescense Antibody Technique (FAT)		100			1232.28	52
2. Confirmation tested by						
2.1)Cell Isolation		1,630			2,762.28	25
2.2)Mouse inoculation test(MIT)		400			1,532.28	25
3. Polymerase Chain Reaction (PCR)		400			1,532.28	7
4. Neutralizing Antibody test for Rabies						
4.1)RFFIT		450			1,582.28	-
4.2)MNT	325.2	2,200	417.2	389.88	3,332.28	49
5. Neutralizing Antibody test for Measle						
5.1) Neutralization test		300			1,432.28	12
5.2)ELISA Measles IgG test		280			1,412.28	86
6.Measle diagnosis by ELISA technique (IgM test)		330			1,462.28	60
7.Measles isolation		290			1,422.28	7
Total						323

Capital cost: Building of NIH

    It was built in 1986 and spent 400 million baht for construction. There have 15,141 square meters; working areas of section of nervous and circulatory system virus are 88 square meters.

Depreciation cost of the building = 400 million/20 = 20 million baht per year or = 20 million / 15,141 sq.m. = 1,320.92 baht per sq.m.

Working areas of this section = 88 * 1,320.92 = 116,240.91 baht per year

Total output of this section = 323 tests then capital cost of building allocated to each test = 116,240.91 / 323 = 389.88 baht per test.

6. Local Government Authority (LGA)

With the coordination between CDC and DLD, they have a policy to transfer rabies control program to LGA. In the year 1999, there has a project of integration of rabies control program to LGA. The target is at least 25% of LGA in year 2000 having integrated rabies control program to their responsibility. The process to run is to conduct every communities to play their roles in controlling of rabies, train the volunteers, allocate their budget and establish a revolving fund for rabies vaccine in animals.

Unfortunately an evaluation of this project has not been done yet, no summarized paper in national level but only have an evaluation by provincial level. With the limitation, the researcher decided to collect available data as possible and interviewed staffs that were directly responsible for this project. Results were illustrated in the table 4.14.

Table 4.14 Estimated percentage of LGA participating in rabies control
        and their budget allocating.

Region	% LGA	Budget allocated
CDC 1	71	3,000-100,000
CDC 2	5	10,000-30,000
CDC 3	30	10,000
CDC 4	27.5	8,700
CDC 5	80	15,000-20,000
CDC 6	n.a.	n.a.
CDC 7	n.a.	n.a.
CDC 8	40	20,000
CDC 9	n.a.	n.a.
CDC 10	5	5,000-10,000
CDC 11	n.a.	n.a.
CDC 12	2	5,000
DLD 2	20	20,000
DLD 3	25	10,000-30,000
DLD 5	5	5,000-10,000

Note: CDC = Communicable Disease Control Regional office
        DLD = Livestock Development Regional office
Source: Collected by documentary reviews [35] and telephone interviews of regional
        staffs

By the data available, approximately 2-80% of LGA (depended on provinces) supported the program, mainly allocating the budget to purchase vaccines for dogs and a few to purchase contraceptive drugs.

To estimate cost of rabies control by LGA, the researcher assumed that 25% of LGA (total 8,000 LGAs) did play the roles and allocate 15,000 baht on average to

support, 90% for dog vaccination and 10% for other programs. Therefore, the conclusion could be summarized in table 4.15.

Table 4.15 Summarized cost and output of rabies control by LGA

Activity	TC	AC*#	Output**
Dog vaccination	27,000,000	35	771,428
Reproduction control	3,000,000	25	120,000
Total	30,000,000		

Note: * By interviewing: vaccine 20 baht, service
          charged by vaccinator 10 baht, other material 5 baht
    ** output was estimated by TC divided by AC.
   # By interviewing: contraceptive drug 15 baht
      service charged by injector 10 baht

We could assume that dog vaccination done by LGA was 771,428 dogs; its average cost 35 baht per injection.

7. Veterinary Private clinics

It is the biggest part of dog vaccination and reproduction control done by veterinary private clinics. In Thailand there are approximately 1,000 clinics across country. Dog's owners mostly bring their pet to receive vaccine and contraception. We can use out-of-pocket money paid by dog's owner to represent costs being occurred at private clinic because this cost would absorb all costs (LC, MC and CC) in which any clinics have had. By small survey and interview it is around 60 baht (range 40-80 baht) per vaccination and price of reproduction control is as followings: contraceptive drug injection for female dog = 50-100 baht, female dog sterilization = 800-1,300 baht and male dog sterilization = 300-500 baht.

An output of dog vaccination by clinic is 1,468,206 (less total number of dog vaccination by an output by DLD, BMA, LGA = 4,277,939 − 1,929,030 − 109,275 − 771,428 = 1,468,206 dogs). In table 4.16, it illustrated outputs of dog vaccination and reproduction control in Thailand and table 4.17 summarized cost of dog rabies control done by veterinary private clinics.

Table 4.16 An output of dog rabies control by organization in 2000
        (Not include Lab in animal).

	Dog population	Dog vaccination	Contraceptive injection	Sterilization female dog	Sterilization male dog
DLD	5,353,381	1,929,030	410,829	32,440	83,376
BMA	633,814	109,275	4,011	3,457	1,578
LGA	-	771,428*	120,000*	-	-
Veterinary private clinic	-	1,468,206*	233,968*	67,323*	69,364*
Total	5,987,195	4,277,939	768,808	103,220	154,318

Note: * estimated output
Source: Division of Disease Control, DLD, MOAC
        Rabies Control Subdivision, BMA
        Interviewing LGA and Veterinary private clinic

Table 4.17 Summarized cost and output done by Veterinary private clinics

Activity	Output	AC	TC*
Dog vaccination	1,468,206	60	88,092,360
Contraceptive	233,968	75	17,547,600
Sterilization			
-male	69,364	400	27,745,600
-female	67,323	1000	67,323,000
Total			200,708,560

Note: * estimated total cost

4.3.2 Empirical results of Postexposure Treatment (PET)

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 Postexposure Vaccination (PEV)

1.1 MOPH hospital

From a record of MOPH and Thai FDA, there were 340,394 cases of PET and 1,365,340 vials of human rabies vaccines being imported; divided into PCEC 650,400 vials, PVRV 712,940 vials and HDCV 2,000 vials. As was known, when bitten by animal or suspected contracting rabies disease, exposed persons must received PEV 5 visits either administering via ID or IM. There have also 1 – 4 visits due to be justified no rabies contracting or omission of treatment by patient itself.

By a small survey, a number of visits (1 – 5 visits) were presented in table 4.18. According to surveying data, total vaccines being consumed by public hospital and number of visits were estimated. Method to calculate and its result were illustrated in figure 4.13.

It was found that public hospital had consumed 644,904 vials divided into 364,530 vials for IM and 280,374 vials for ID. When it was changed to number of visits: 364,530 visits for IM and 546,795 visits for ID.

1.2 University, Military, BMA hospital

By telephone interviews with 5 of 10 university hospitals, which are not under MOPH, were found that they purchased rabies vaccines around 2,840 – 8,960 vials in year 2000. Therefore, the researcher will apply an average number, 5,900 vials per hospital. There were 59,000 vials of rabies vaccines being consumed.

There are also military hospitals, which were asked via telephone. Those, 3 of 7 general and referred hospitals, were interviewed. They purchased 600 – 3,150 vials in year 2000. In addition, there are some small hospitals under military located at military camps all over Thailand. The researcher supposed that approximately 25,000 vials were consumed by military hospitals.

Finally, hospitals under BMA were asked via telephone interviews. There were 3 of 5 general and referred hospitals to be interviewed. It was found that they purchased rabies vaccines 2,000 – 6,000 vials in year 2000. BMA also has 4 community hospitals and 61 health centers around Bangkok. The researcher supposed that approximately 25,000 vials were consumed by BMA hospitals and health centers.

In conclusion, rabies vaccines that were 109,000 vials used by not-MOPH and not-private hospitals in year 2000.

When applying proportion of administering of vaccine IM:ID of 40:60, it found that:
-   IM used 43,600 vials. Supposing all exposed persons received a complete course (5 doses or 5 vials of vaccines), then, there had 8,720 cases of exposed or 43,600 visits.
-   ID used 65,400 vials. Supposing all exposed persons received a complete course (3 vials of vaccines) then, there had 21,800 cases of exposed or 109,000 visits.

1.3 QSMI

Record of QSMI, number of vaccines purchased were 10,000 vials in year 2000.

1.4 Private hospital

After less number of vaccines consumed by QSMI, MOPH, University, Military and BMA hospital, the remaining vaccines are 601,346 vials, in which the researcher assumed this amount being consumed by private hospitals. From interviewing some private hospitals, they have usually administered rabies vaccine by IM and most of patients received a complete course of treatment. After calculating there were 120,287 vaccinees or approximately 601,345 visits of patients, receiving care at private hospital.

Cost of PEV was summarized in table 4.19.

Table 4.18 Surveying data of number of visits of exposed persons who sought care from public hospital.

Visit(s)	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Hospital 6	Hospital 7	Hospital 8	Total	%
5 visits	17	4	2	94	18	44	6	21	206	12.13
4 visits	3	25	5	27	8	106	11	36	221	13.02
3 visits	105	33	96	46	18	141	45	28	512	30.15
2 visits	21	3	30	28	4	145	75	31	337	19.85
1 visits	23	0	34	20	7	180	116	42	422	24.85
case	169	65	167	215	55	616	253	158	1698	100.00

Note: This available data in year 2002 collected from hospital in the north of Thailand.

Figure 4.13 Method to calculate number of visits and vaccine consumed by MOPH hospitals, Year 2000

PET
340,394

IM
0.4
136,158

Visit(s)	%	PET (case)	Number of visits	Vaccine consumed (vials)
5	12.13	16,519	82,593	82,593
4	13.02	17,721	70,885	70,885
3	30.15	41,056	123,167	123,167
2	19.85	27,023	54,046	54,046
1	24.85	33,839	33,839	33,839
Total		136,158	364,530	364,530

ID
0.6
204,236

Visit(s)	%	PET (case)	Number of visits	Vaccine consumed (vials)
5	12.13	24,778	123,889	74,333
4	13.02	26,582	106,328	53,164
3	30.15	61,584	184,751	61,584
2	19.85	40,535	81,069	40,535
1	24.85	50,758	50,758	50,758
Total		204,236	546,795	280,374

Note: PET is a record of hospital under MOPH

Public Hospital administered by IM 40%, ID 60%

IM type comsumed 1 vial per visit, ID type consumed at 1st, 2nd, 3rd = 1 vial and 4th = 2 vials, 5th = 3 vials

See Appendix for detail how to administer vaccine

Total vaccine imported in year 2000 (record from Thai FDA) = 1,365,340 vials (PCEC 650,400 vials, PVRV 712,940 vials, HDCV 2,000 vials)

Total vaccine consumed by MOPH hospita   644,904   vials

Total vaccine consumed by military hospital, university hospital and BMA ho   109,000 vials

Total vaccine storage at QSMI =   10,000   vials but consumed 7,850 vials as was recorded.

Total vaccine consumed by private hospital   601,436 vials

Table 4.19 Cost of PEV

Organization	Output (visits)	AC**	TC
MOPH hospital*			
- ID	546,795	267.49	146,262,195
- IM	364,530	391.23	142,615,072
Military, University and BMA hospital*			
- ID	109,000	267.49	29,156,410
- IM	43,600	391.23	17,057,628
Private hospital	601,435	767.18	461,408,903
QSMI (ID&IM)	18,042	631.69	11,396,951
Total	1,683,402	479.92	807,897,159

Note: * Operating cost
   ** See Appendix for detail how to calculate
   ** AC was included rabies vaccine and RIG 5% of vaccinees
      except QSMI, it is 10%

2. Cost of treatment for rabies patient

This was occurred only for IPD case. Therefore, this study can employ the DRG system to calculate the cost. As usually accepted for DRG, it is a method to estimate the cost of treatment for any particular diseases. It is important to be cited Relative Weight (RW) which was involved in computing cost in DRG. This is a comparative weight of any particular diseases to the average weight of overall diseases. There will be calculated 1 RW into expenditure to get the cost per RW. In year 2000, 1 RW was equal to 4,000 baht. If we search a code for rabies in DRG system, we found that Rabies disease (ICD10 code = A52, DRG code = 423) has RW[#] = 1.226 unit then cost of treatment per patient is 1.226*4,000 = 4,904 baht. Not surprisingly how cheap for treating such patient it can be explained by a following reason. Rabies is an unavoided death when showing its sign and symptom and no one can be cured but only symptomatic treatment is provided to him. Usually after showing rabid symptom, most of patients would frequently die within 3 days. For its ability to spread is possibly any person who has closely contact with patient in a period of expressing the symptom. However this person will immediately be notified and given a vaccine by outbreak control team when rabies was being detected.

In year 2000 there were 50 rabies case reported. So their cost of treatment are 50*4,904 = 245,200 baht.

3. Cost of treatment for immunoglobulin side effect

Similar to cost of treatment for rabies patient, it is the same method to calculate cost of side effect treatment. In year 2000 an adverse reaction after ERIG use had been reported to the Division of Adverse Product Reaction Surveillance; Thai

[#] Source: Health Insurance Office, MOPH

FDA, MOPH (see table 4.20). As was estimated in previous study (Piriyasupong K, 2001), it was shown in table 4.21.

Table 4.20 Report of Adverse Reaction Product Reaction Surveillance,
　　　　　Thai FDA, MOPH year 2000.

Type of Adverse Reaction	Sex	Age	Type of patient
Bronchospasm	Female	62	IPD
Dyspnea	Female	34	OPD
Edema	Female	21	IPD
Periorbital edema	Female	34	OPD
Erythematous rash	Female	62	OPD
Erythematous rash	Female	34	OPD
Erythematous rash	Female	7	OPD
Erythematous rash	Female	35	OPD
Urticaria	Male	16	OPD
Urticaria	Female	7	OPD
Urticaria	Female	24	OPD

Source: Unit of Adverse Product Reaction Surveillance, Thai FDA,MOP

Table 4.21 DRG and RW of the Adverse Reaction, DRG Tools Book,
　　　　　MOPH year 2000.

Disease	ICD10	DRG	RW	Number of patients	Cost (baht)
Asthma	J45	98	0.4721	2	3,777
Periorbital edema	H052	45	0.83	1	3,320
Rash	R21	284	0.6454	4	10,326
Urticaria	L50	284	0.6454	3	7,745
Total					25,168

Source: Health Insurance Office, MOPH

In summary cost of treatment for immunoglobulin side effect is 25,168 baht.

4. Cost of laboratory diagnosis in human

Data from department of Medical Science was reported that in year 2000 it had 7 tests to diagnose rabies (see table 4.12). Total cost is 10,725.96 baht.

Costs of PET

Due to assumption of costs of PET that are the combination of PEV cost, cost of treatment for rabies patient, cost of treatment for immunoglobulin side effect, cost of laboratory diagnosis in human. Therefore, they could be summarized in table 4.22.

Table 4.22 Total cost of human postexposure treatment

Activity	TC (baht)
PEV	807,897,159
Treatment for rabies patient	245,200
Treatment for side effect of immunoglobulin	25,168
Lab diagnosis in human	10,725.96
Total	808,178,253

Total visits of PET in year 2000
= MOPH hospital + (Military, University, BMA) hospital +
Private hospital + QSMI
= 911,325 + 152,600 + 601,435 + 18,042
= 1,683,402 visits

Then cost per visits $= \dfrac{TC}{Visits}$

$= \dfrac{808,178,253}{1,683,402}$

= 480.08 baht per visit

A conclusion of cost of rabies control in Thailand and outputs could be summarized in table 4.23 – 4.24.

Table 4.23 An output, total cost and average cost of dog rabies control
by organization in year 2000

Organization	Dog vaccination			Laboratory diagnosis in animal			Other programs
	Output (dog)	AC (baht)	TC (baht)	Output (dog)	AC (baht)	TC (baht)	TC (baht)
DLD	1,929,030	38.30	73,888,482	2,198	4,158.92	9,141,306.16	37,927,281.00
QSMI	-	-	-	1,215	1,365.29	1,658,827.35	-
BMA	109,275	92.68	10,127,607	-	-	-	11,565,160.50
CDC	-	-	-	-	-	-	4,390,890.00
DMSc	-	-	-	611	1,408.00	860,288.00	-
LGA	771,428*	35.00	26,999,980	-	-	-	3,000,000.00
Private clinic	1,468,206	60.00	88,092,360**	-	-	-	112,616,200.00
Total	4,277,939	46.54	199,108,429	4,024	2,897.72	11,660,422	169,499,531.50

Note: * estimated output derived from dividing total cost by average cost
** estimated cost derived from multiplying an output with average cost

Table 4.24 An output, total cost and average cost of human
postexposure treatment (PET) in year 2000

Activity	MOPH,University,Military,BMA hospital			Private Hospital			QSMI		
	Output (visits)	AC* (baht)	TC (baht)	Output (visits)	AC (baht)	TC (baht)	Output (visits)	AC (baht)	TC (baht)
PEV									
- ID	655,795	267.49	175,418,605	-	-	-	-	-	-
- IM	408,130	391.23	159,672,700	601,435	767.18	461,408,903	-	-	-
- ID&IM	-	-	-	-	-	-	18,042	631.69	11,396,951
Rabies patient care	-	-	245,200	-	-	-	-	-	-
RIG side effect	-	-	25,168	-	-	-	-	-	-
Lab in human	-	-	10,725.96	-	-	-	-	-	-
Total			335,372,398			461,408,903			11,396,951

Cost per visit = 808,178,253 / 1,683,402 = 480.08 baht
Note: * operating cost

4.4 Estimating Incremental Cost and Benefit of the Intensified-Dog Control Program

4.4.1 Incremental cost

The facts that there are 4 costs of rabies control:
1. Cost of PET
2. Cost of Dog vaccination
3. Cost of Laboratory Diagnosis in animal
4. Cost of other programs (Dog population control and related campaigns)

In order to calculate incremental cost, an output of rabies control activity has to be identified and calculated its cost. An actual output and estimated output during three years of implementation were taken into account (see table 4.25).

Table 4.25 An actual output and estimated output in year 2000-2003

Activity	Output (cases)			
	2000	2001	2002	2003
PET				
- MOPH hospital (1)	340,394	351,141	376,891	402,641
-University, Military and BMA hospital (2)	30,520	31,462	33,769	36,076
- Private hospital(3)	120,287	124,058	133,155	142,253
Dog vaccination (4)	4,277,939	4,579,079	3,848,134	4,332,999
Lab in animal (5)	4,024	3,329	2,961	2,642

Source: DLD; MOAC, CDC; MOPH, DMSc; MOPH, QSMI; TRC-S,
BMA

Note: (1) An actual output in 2001 is 351,141 cases. It is estimated in year 2002, 2003 by using 25,750 cases increase per year (see Appendix 5). We cannot use 14.7% increasing rate because there have outlier data in 2000 and 2001. If we use 14.7%, in year 2002 and 2003 there will be 402,759 and 461,965 cases respectively. Observe at present data, it is impossible that PET could reach at that amount.

(2) An estimated output of University, Military and BMA hospitals was calculated by using the ratio of PET at MOPH hospital to University, Military and BMA hospital = 1: 0.0896

(3) An estimated output of private hospital that was calculated by using the ratio of PET at MOPH hospital to private hospital = 1:0.3533

(4) An actual output in 2002 is 3,848,134. It is an estimate in year 2003 by using 12.6% increasing rate (see Appendix 6).

(5) An actual output in 2002 is 2,961 specimens. It is an estimate in year 2003 by using 10.8% decreasing rate (see Appendix 7).

From table 4.25, a number of PET have to be changed into a number of visits due to a vaccinee might receive care 1 – 5 visits (see table 4.26). Therefore, the number of visits would be calculated total cost of PET.

Table 4.26 A number of visits of vaccinees

Year	2000	2001	2002	2003
PEV				
-MOPH hospital*	911,325	940,098	1,009,038	1,077,978
-University, Military and BMA hospital**	152,600	157,310	168,845	180,380
-Private hospital***	601,435	620,290	665,775	711,265
-QSMI****	18,042	16,102	10,812	10,000
Total	1,683,402	1,733,800	1,854,470	1,979,623

Note: * See Appendix 10 for method how to calculate
     ** Number of vaccinee multiplied by 5 visits
     *** Number of vaccinee multiplied by 5 visits
     **** An actual visit in 2000-2002 and estimated in 2003

Data in table 4.25 – 4.26 are outputs that have occurred in current situation and been able to calculate their costs (see table 4.27). With regard to the intensified-dog control program, dog vaccination coverage must be executed at least 80% of dog population in that particular year. And it is assumed that other activities have been undergone in the same pattern (see table 4.28). Cost of both programs can be compared and an incremental cost of the intensified program will be the answer (see table 4.29).

Table 4.27 An estimate of cost of rabies control in **current practice** (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	4,579,079	213,110,337	3,848,134	179,092,156	4,332,999	201,657,773
Dog population	n.a.	5,953,249		6,298,644		6,366,000*	
%coverage	n.a.	76.92		61.09		68.06	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,224,619,082		1,247,465,794		1,329,190,491

Note: * no data of dog population available in year2003 so it is estimated with ratio 1:10
     # AC in year 2000

The three-year expenses for current practice are 1,224,619,082 + 1,247,465,794 + 1,329,190,491 = 3,801,275,367 baht

Table 4.28 An estimate of cost of rabies control in **the intensified program** (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	4,762,599	221,651,357	5,038,915	234,511,104	5,092,800	237,018,912
Dog population	n.a.	5,953,249		6,298,644		6,366,000*	
%coverage	n.a.	80.00		80.00		80.00	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,233,160,102		1,302,884,742		1,364,551,629

Note: * no data of dog population available in year2003 so it is estimated with ratio 1:10
  # AC in year 2000

The three-year expenses for the intensified program are 1,233,160,102 + 1,302,884,742 + 1,364,551,629 = 3,900,596,473 baht.

Table 4.29 Incremental cost of the intensified program for 3 years (Currency: baht)

Program	3-year cost (baht)
Current practice	3,801,275,367
Intensified Program	3,900,596,473
Incremental cost	99,321,106

Note: Value in year 2000

As was seen above, an incremental cost computed from an output of the three-year implementation of two programs is 99,321,106 baht.

4.4.2 Incremental benefit

The 10-year retrospective data (1991-2000) are illustrated deaths by age group (see Table 4.30). It is found that 42.91% of rabies was in people below 15.

Table 4.30 Report cases of rabies by age group during 1991 – 2000

Age (years)	0-14	15-24	25-34	35-44	44-54	55-64	65+	Total
1991	85	15	13	10	19	17	12	171
1992	45	10	11	18	8	10	11	113
1993	49	9	9	6	6	7	7	93
1994	33	6	6	14	5	7	7	78
1995	33	6	10	6	9	8	2	74
1996	33	3	11	10	7	6	7	77
1997	27	6	6	8	7	2	2	58
1998	19	11	6	8	5	5	3	57
1999	25	7	6	9	9	6	6	68
2000	11	9	6	8	3	7	6	50
Subtotal	360	82	84	97	78	75	63	839
%	42.91	9.77	10.01	11.56	9.30	8.94	7.51	100

Source: Division of epidemiology, MOPH

The number of deaths in year 2001, 2002 was 37, 31 cases respectively and in year 2003 in which an estimate of decreasing rate of death per year during 1981-2002 was approximately 16-19% (see Appendix 4 for how to calculate) is expected to have 25 cases (see Table 4.31). Accordingly after implementing the intensified program the expected death is of 20% of the initial rate (Bogel K, 1990) for the first two-year and none in the third year. We considered year 2000 was a year before implementation. Therefore the expected death is 10, 10 and 0 for 3 consecutive years (see Table 4.31)

Table 4.31 Actual and estimated cases of rabies by age group of current practice and intensified program between 2001-2003

Age (years)	year 2001		year 2002		year 2003	
	Current[#]	Intensified[*]	Current[#]	Intensified[*]	Current +	Intensified[*]
0-15	13	4	9	4	11	0
15-24	3	1	3	1	2	0
25-34	3	1	7	1	3	0
35-44	3	1	2	1	3	0
45-54	8	1	4	1	2	0
55-64	3	1	4	1	2	0
65+	4	1	2	1	2	0
Total	37	10	31	10	25	0

\# Actual number of cases
* Estimated number of cases by using 20% of initial rate; year2000 (Bogel K,1990)
+ Estimated number by 16-19% decreasing rate per year (see appendix 4)
Source: Division of epidemiology, MOPH

Record of death by provincial level to be presented was as follows:

Year 2001 = 37 deaths, it had been occurred at
- Bangkok 8 deaths; age 5 year = 1, age 7-9 year = 1, age 10-14 year = 1, age 25-34 year = 1, age 35-44 year = 2, age 45-54 year = 1, age 55-64 year = 1
- Samut Prakan 2 deaths; age 10-14 year = 1, age 25-34 year = 1
- Pathum Thani 1 death; age 7-9 year = 1
- Chonburi 1 death; age 35-44 year = 1
- Sa Kaew 2 deaths; age 7-9 year = 1, age 55-64 year = 1
- Ratchaburi 3 deaths; age 7-9 year = 2, age 15-24 year = 1
- Kanchanaburi 1 death; age 1 year = 1
- Samut Sakhon 1 death; age 55-64 year = 1
- Prachuap Khiri Khun 1 death; age 10-14 year = 1
- Nakhon Ratchasima 2 deaths; age 45-54 year = 2
- Surin 2 deaths; age 25-34 = 1, age 45-54 year = 1
- Si Sa Ket 1 death; age 3 year = 1
- Ubon Ratchathani 1 death; age 25-34 year = 1
- Phitsanulok 1 death; age 65+ year = 1
- Phichit 1 death; age 45-54 year = 1
- Mae Hong Son 1 death; age 45-54 year = 1
- Nakhon Si Thammarat 3 deaths; age 10-14 year = 1 death, age 15-24 year = 1 death, age 65+ year = 1
- Ranong 1 death; age 7-9 year = 1
- Songkhla 3 deaths; age 45-54 year = 1, age 65+ year = 2
- Trang 1 death; age 45-54 year = 1

Year 2002 = 31 cases, it had been occurred at
- Nonthaburi 1 death; age 3 year = 1
- Pathum Thani 1 death; age 10-14 year = 1
- Chonburi 1 death; age 45-54 = 1
- Rayong 1 death; age under 14 = 1
- Chanthaburi 2 death; age 25-34 = 2
- Prachin Buri 3 death; age 4 year = 1, age 8 year =1, age 15-24 year = 1
- Nakhon Pathom 1 death; age 9 year = 1
- Nakhon Ratchasima 1 death; age 55-64 year = 1
- Buri Ram 2 deaths; age 15-24 year = 2
- Surin 2 deaths; age 25-34 year = 1, age 45-54 year = 1
- Sakon Nakhon 1 death; age 35-44 year = 1
- Si Sa Ket 2 deaths; age 25-34 year = 1, age 65+ year = 1
- Ubon Ratchathani 1 death; age 45-54 year = 1
- Yasothon 1 death; age 25-34 year = 1
- Nakhon Phanom 1 death; age 45-54 year = 1
- Nakhon Sawan 2 death; age 1 year = 1, age under 14 = 1
- Pichit 1 death; age 55-64 year = 1
- Chiang Mai 3 deaths; age 6 year = 1, age 55-64 year = 2
- Nakhon Si Thammarat 1 death; age 35-44 year = 1
- Krabi 1 death; age 65+ = 1
- Ranong 1 death; age 25-34 year = 1
- Songkhla 1 death; age 25-34 year = 1
  - Note: preliminary report by Division of Epidemiology, MOPH

<u>Year 2003</u>

   Estimated 25 cases and unable to be categorized

   Income foregone due to premature death of Thai population caused by rabies will be valued its productivity lost by using human capital approach. From a formula below

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

Assumption: Working age is 15 to 60 years old.

<u>Parameter g</u>: referred to economic growth (see Table 4.32), this study used the average GDP growth during 2000-2003.

   GDP at current price in 2000 was 4,916.5 billion Baht and in 2003 estimated by NESDB was 5,799.7 billion Baht.

$$(1+g)^n \, 4,916.5 = 5,799.7$$
$$(1+g)^4 = 1.18$$
$$g = 0.042$$

<u>Parameter r</u>: referred to discount rate. The discount rate for benefits is often thought to compromise two parts. One is a "pure" time preference for immediate over postponed consumption. The second relates to the fact that, as the prosperity of a society increases, the utility or benefit to it of a defined unit of consumption is less – that is, there is declining marginal utility of a unit of consumption as income rises. Many cost-effectiveness studies have assumed that this applies to health benefits as well and have discounted future health at a rate between 3% and 5% per year. This practice has long been debated, and some people have argued that discount rate for health benefits should be close to zero and certainly less than the discount rate for costs.

   Not all health care programs achieve results at the same rate. Public health and health promotion programs in particular may take many years to produce tangible results, and applying a discount rate to the benefits of such program will reduce their apparent attractiveness compared with programs that produce rapid benefits of a similar magnitude.

   Common practice remains to discount costs and benefits at the same rate, so we follow the same practice in our baseline calculations using a rate of 3% (WHO, world health report, 2002) (The Thai group on Burden of Disease and Injuries, Burden of Disease and Injuries in Thailand, 2002) and used 5% for sensitive test.

<u>Parameter I</u>: represented by per Capita GDP in year 2001, 2002, 2003 because per Capita GPP could not be acquired at this moment.

Table 4.32 Economic Indicators of Thailand during 2000-2003

	2000	2001	2002	2003
Population (millions)	61.88	62.31	63.06	63.66
GDP (billion baht)	4,916.5	5,123.4	5,430.5	5,799.7
Employment (millions)*	31.446	32.109	32.795	33.86
per Capita GDP	77,362	80,083	86,121	91,100

Source: Bank of Thailand, March, 2003
  Office of the National Economic and Development Board, March,2003
   * Age 15 years over

Table 4.33 The Income Foregone from Current Practice and the Intensified Program, Year 2001(r = 0.03, g = 0.042 and per Capita GDP = 80,083 baht) (Currency: baht)

Year 2001		current		intensified	
Age (year)	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-14	4,757,263	13	61,844,417	4	19,029,051
15-24	4,226,291	3	12,678,872	1	4,226,291
25-34	3,003,464	3	9,010,392	1	3,003,464
35-44	1,914,384	3	5,743,151	1	1,914,384
45-54	944,421	8	7,555,371	1	944,421
55-64	80,884	3	242,651	1	80,884
65+		4		1	
total		37	97,074,854	10	29,198,495
Present value in year 2000			94,247,431		28,348,053

Table 4.34 The Income Foregone from Current Practice and the Intensified Program, Year 2002(r = 0.03, g = 0.042 and per capita GDP = 86,121 Baht) (Currency: baht)

Year 2002		current		intensified	
Age (year)	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-14	5,115,945	9	46,043,506	4	20,463,780
15-24	4,544,939	3	13,634,818	1	4,544,939
25-34	3,229,916	7	22,609,409	1	3,229,916
35-44	2,058,722	2	4,117,444	1	2,058,722
45-54	1,015,628	4	4,062,511	1	1,015,628
55-64	86,982	4	347,929	1	86,982
65+		2	-	1	
total		31	90,815,616	10	31,399,967
Present value in year 2000			85,602,428		29,597,481

Table 4.35 The Income Foregone from Current Practice and the Intensified Program, Year 2003(r = 0.03, g = 0.042 and per capita GDP = 91,100 Baht) (Currency: baht)

Year 2003		current		intensified	
Age (year)	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-14	5,411,718	11	59,528,902	0	0
15-24	4,807,700	2	9,615,401	0	0
25-34	3,416,650	3	10,249,950	0	0
35-44	2,177,745	3	6,533,236	0	0
45-54	1,074,345	2	2,148,690	0	0
55-64	92,011	2	184,022	0	0
65+		2	-	0	0
total		25	88,260,200	0	0
Present value in year 2000			80,770,586		0

Table 4.36 The Income Foregone from Current Practice and the Intensified Program, Year 2001(r = 0.05, g = 0.042 and per Capita GDP = 80,083 baht) (Currency: baht)

Year 2001		current		intensified	
Age (year)	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-14	3,037,364	13	39,485,729	4	12,149,455
15-24	2,807,906	3	8,423,717	1	2,807,906
25-34	2,202,015	3	6,606,044	1	2,202,015
35-44	1,547,965	3	4,643,896	1	1,547,965
45-54	841,930	8	6,735,441	1	841,930
55-64	79,777	3	239,332	1	79,777
65+		4		1	
total		37	66,134,160	10	19,629,048
Present value in year 2000			62,984,914		18,694,332

Table 4.37 The Income Foregone from Current Practice and the Intensified Program, Year 2002(r = 0.05, g = 0.042 and per capita GDP = 86,121 Baht) (Currency: baht)

Year 2002		current		intensified	
Age (year)	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-14	3,266,371	9	29,397,341	4	13,065,485
15-24	3,019,613	3	9,058,838	1	3,019,613
25-34	2,368,039	7	16,576,275	1	2,368,039
35-44	1,664,677	2	3,329,354	1	1,664,677
45-54	905,409	4	3,621,636	1	905,409
55-64	85,792	4	343,169	1	85,792
65+		2	-	1	
total		31	62,326,614	10	21,109,015
Present value in year 2000			56,532,076		19,146,499

Table 4.38 The Income Foregone from Current Practice and the Intensified Program, Year 2003(r = 0.05, g = 0.042 and per capita GDP = 91,100 Baht) (Currency: baht)

Year 2003		current		intensified	
Age (year)	income foregone	Life lost	Total income lost	life lost	Total income lost
0-14	3,455,213	11	38,007,346	0	0
15-24	3,194,189	2	6,388,377	0	0
25-34	2,504,945	3	7,514,836	0	0
35-44	1,760,918	3	5,282,755	0	0
45-54	957,754	2	1,915,509	0	0
55-64	90,752	2	181,505	0	0
65+		2		0	0
total		25	59,290,327	0	0
Present value in year 2000			51,217,214		0

Summing up 3 year-discounted values of current practice and the intensified program is in Table 4.39.

Table 4.39 Total income foregone of current practice and the intensified program in present value year 2000 (Currency: baht)

	Estimate A		Estimate B	
Year	Current (C)	Intensified (I)	Current (C)	Intensified (I)
2001	94,247,431	28,348,053	62,984,914	18,694,332
2002	85,602,428	29,597,481	58,532,076	19,146,499
2003	80,770,586	-	51,217,214	-
Total	260,620,445	57,945,534	172,734,204	37,840,831
Incremental benefit (C-I)		202,674,911		134,893,373

Estimate A = per Capita GDP and discount rate 3%
Estimate B = per Capita GDP and discount rate 5%

It is in Estimate A; an incremental benefit to be saved would be higher than Estimate B.

4.4.3 Comparison of Benefit / Cost ratio

From the model, it was found that the three-year expenses of the current practice were 3,801,275,367 baht (value in year 2000) and the estimated expenses of the intensified program were 3,900,596,473 baht (value in year 2000). The difference is 99,321,106 baht, which is an incremental cost needed to purchase dog rabies vaccines so as to cover 80% of dog population.

According to the results of estimating income foregone during 3 years of the program converting life into monetary value were in the table 4.40.

Table 4.40 Income foregone of the current practice and the intensified program during 3 years: 2 Estimates (Currency: baht)

	Current practice (C)	Intensified program (I)	C-I
Estimate A	260,620,455	57,945,534	202,674,921
Estimate B	172,734,204	37,840,831	134,893,373

Note: Estimate A = per Capita GDP, discount rate 3%
      Estimate B = per Capita GDP, discount rate 5%

The difference is the incremental benefit of the intensified program derived from life saved in case of 80% of dog vaccination coverage during 3 years of implementation. And when comparing to incremental cost, the results were presented in table 4.41.

Table 4.41 Benefit / Cost ratio of the 3-year program (Currency: baht)

Estimate	Incremental benefit	Incremental cost	B / C
A	202,674,911	99,321,106	2.04
B	134,893,373	99,321,106	1.36

Note: Estimate A = per Capita GDP, discount rate 3%
      Estimate B = per Capita GDP, discount rate 5%

4.5 Sensitivity Analysis

4.5.1 A change of incremental cost

Increasing dog population will test the sensitive results of cost. On average, dog to human ratio is 1:10.3. Results were showed in table 4.42 – 4.51.

Table 4.42 An estimate of cost of rabies control in **current practice**
If dog : human ratio = 1 : 6.72 (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	4,579,079	213,110,337	3,848,134	179,092,156	4,332,999	201,657,773
Dog population *	n.a.	9,272,321		9,383,929		9,473,214	
%coverage	n.a.	49.38		41.01		45.74	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,224,619,082		1,247,465,794		1,329,190,491

Note: * See Appendix 8 for detail how to calculate
      # AC in year 2000

Table 4.43 An estimate of cost of rabies control in **the intensified program**
If dog : human ratio = 1 : 6.72 (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	7,417,857	345,227,055	7,507,143	349,382,445	7,578,571	352,706,704
Dog population *	n.a.	9,272,321		9,383,929		9,473,214	
%coverage	n.a.	80.00		80.00		80.00	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,356,735,800		1,417,756,082		1,480,239,421

Note: * See Appendix 8 for detail how to calculate
      # AC in year 2000

Table 4.44 Incremental cost of the intensified program
If dog : human ratio = 1 : 6.72 (Currency: baht)

Program	3-year cost (baht)
Current practice	3,801,275,367
Intensified Program	4,254,731,303
Incremental cost	453,455,936

Note: Value in year 2000

Table 4.45 An estimate of cost of rabies control in **current practice**
If dog : human ratio = 1 : 10 (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	4,579,079	213,110,337	3,848,134	179,092,156	4,332,999	201,657,773
Dog population *	n.a.	6,231,000		6,306,000		6,366,000	
%coverage	n.a.	73.49		61.02		68.06	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,224,619,082		1,247,465,794		1,329,190,491

Note: * See Appendix 8 for detail how to calculate
    # AC in year 2000

Table 4.46 An estimate of cost of rabies control in **the intensified program**
if dog : human ratio = 1 : 10 (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	4,984,800	231,992,592	5,044,800	234,784,992	5,092,800	237,018,912
Dog population *	n.a.	6,231,000		6,306,000		6,366,000	
%coverage	n.a.	80.00		80.00		80.00	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,243,501,337		1,303,158,630		1,364,551,629

Note: * See Appendix 8 for detail how to calculate
    # AC in year 2000

Table 4.47 Incremental cost of the intensified program
If dog : human ratio = 1 : 10 (Currency: baht)

Program	3-year cost (baht)
Current practice	3,801,275,367
Intensified Program	3,911,211,596
Incremental cost	109,936,229

Note: Value in year 2000

Table 4.48 An estimate of cost of rabies control in **current practice**
If dog : human ratio = 1 : 15 (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	4,579,079	213,110,337	3,848,134	179,092,156	4,332,999	201,657,773
Dog population *	n.a.	4,154,000		4,204,000		4,244,000	
%coverage	n.a.	110.23		91.54		102.10	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,224,619,082		1,247,465,794		1,329,190,491

Note: * See Appendix 8 for detail how to calculate
     # AC in year 2000

Table 4.49 An estimate of cost of rabies control in the **intensified program**
if dog : human ratio = 1 : 15 (Currency: baht)

Activity	AC#	2001		2002		2003	
		Output	TC	Output	TC	Output	TC
PET	480.08	1,733,800	832,362,704	1,854,470	890,293,958	1,979,623	950,377,410
Dog vaccination	46.54	3,323,200	154,661,728	3,363,200	156,523,328	3,395,200	158,012,608
Dog population *	n.a.	4,154,000		4,204,000		4,244,000	
%coverage	n.a.	80.00		80.00		80.00	
Lab diagnosis in animal	2,897.72	3,329	9,646,510	2,961	8,580,149	2,642	7,655,776
other programs	n.a.	n.a.	169,499,531	n.a.	169,499,531	n.a.	169,499,531
Total			1,166,170,473		1,224,896,966		1,285,545,325

Note: * See Appendix 8 for detail how to calculate
     # AC in year 2000

Table 4.50 Incremental cost of the intensified program
If dog : human ratio = 1 : 15 (Currency: baht)

Program	3-year cost (baht)
Current practice	3,801,275,367
Intensified Program	3,676,612,764
Incremental cost	-124,662,603

Note: Value in year 2000

Results of the sensitive test, when changing ratio of dog to human of 1: 6.72, 1: 10 and 1: 15, were found that a huge amount of money would be spent if dog population were high. On the other hand, a small number of dog population would be, no need of money were to spend anymore. An incremental cost, when changing ratio of dog to human, was presented in table 4.51 and figure 4.14.

Table 4.51 A ratio of dog to human and incremental cost in the 3-year program

Ratio of Dog to Human	Incremental cost (baht)
1:5	813,732,726
1:6	579,133,894
1:6.72	453,445,936
1:7	411,563,319
1:8	285,885,354
1:9	188,135,828
1:10	109,936,230
1:11	45,954,696
1:12	-7,363,186
1:13	-52,478,357
1:14	-91,148,497
1:15	-124,662,602

Note: Value in year 2000
Source: Author's calculation

Fig 4.14 Sensitivity Analysis: Changing the ratio of dog to human
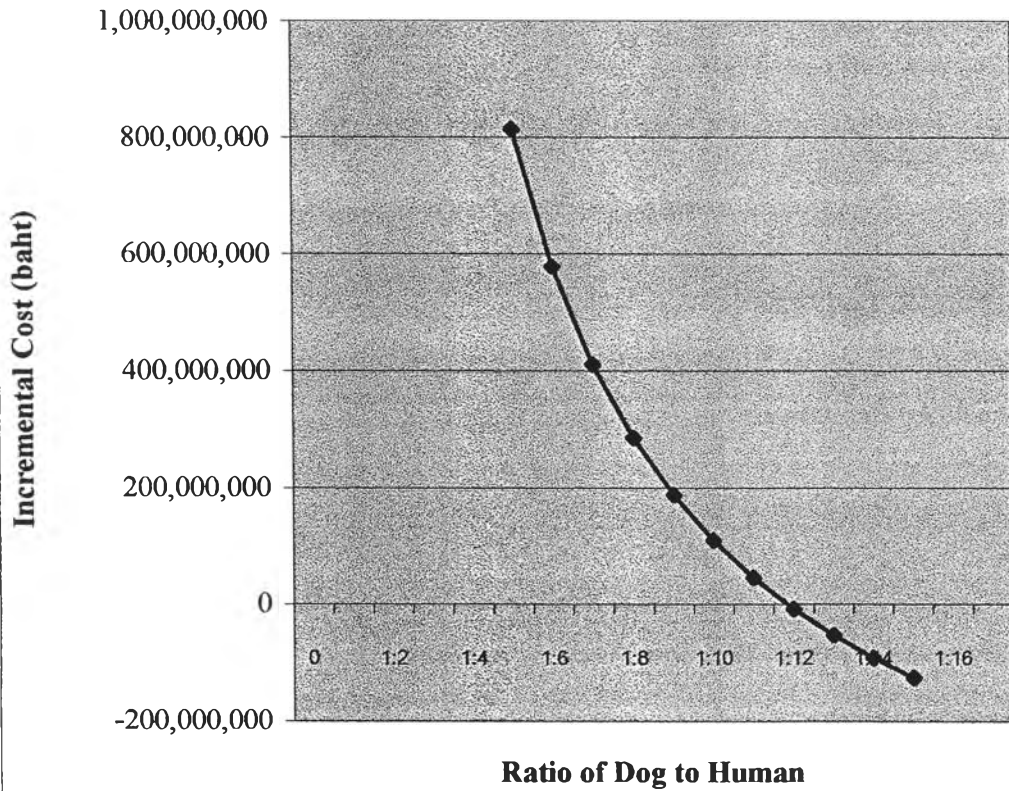
4.5.2 A change of incremental benefit

Increasing a number of deaths in the intensified program will test the sensitive results of benefit. On the assumption of Bogel K (1990), it was expected to have deaths 20% of the initial rate. If the assumption given by Bogel K (1990) was uncertain and then number of deaths in the intensified program was varied from 20% to 50% of the initial rate in the first year and the second year. Results were showed in table 4.52– 4.56.

Table 4.52 Illustrate a number of deaths when changing % of the assumption

% deaths of initial rate*	Year			Total death
	2001	2002	2003	
20%	10	10	0	20
30%	15	15	0	30
40%	20	20	0	40
50%	25	25	0	50

Note: * Initial rate was 50 deaths in year 2000.
In year 2002, the researcher kept the number of deaths as year 2001 because of pessimistic view.

Table 4.53 Illustrate income saved when % of deaths = 30% (Currency: baht)

Year 2001: r = 0.03, g = 0.042, per Capita GDP = 80,083 baht per year

Year 2001		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	4,757,262.82	13	61,844,417	6	28,543,577
15-24	4,226,290.52	3	12,678,872	2	8,452,581
25-34	3,003,464.07	3	9,010,392	2	6,006,928
35-44	1,914,383.83	3	5,743,151	2	3,828,768
45-54	944,421.34	8	7,555,371	1	944,421
55-64	80,883.83	3	242,651	1	80,884
65+		4	-	1	-
Total		37	97,074,854	15	47,857,159
Present value in 2000			94,247,431		46,463,261

Year 2002: r = 0.03, g = 0.042, per Capita GDP = 86,121 baht per year

Year 2002		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	5,115,945.09	9	46,043,506	6	30,695,671
15-24	4,544,939.20	3	13,634,818	2	9,089,878
25-34	3,229,915.58	7	22,609,409	2	6,459,831
35-44	2,058,722.19	2	4,117,444	2	4,117,444
45-54	1,015,627.66	4	4,062,511	1	1,015,628
55-64	86,982.21	4	347,929	1	86,982
65+		2	-	1	-
Total		31	90,815,616	15	51,465,434
Present value in 2000			85,602,428		48,511,108

Year 2003: r = 0.03, g = 0.042, per Capita GDP = 91,100 baht per year

Year 2003		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	5,411,718	11	59,528,902	0	-
15-24	4,807,700	2	9,615,401	0	-
25-34	3,416,650	3	10,249,950	0	-
35-44	2,177,745	3	6,533,236	0	-
45-54	1,074,345	2	2,148,690	0	-
55-64	92,011	2	184,022	0	-
65+		2		0	-
Total		25	88,260,200	-	-
Present value in 2000			80,770,586		-

Total 3-year income lost in current practice = 260,620,446 baht

Total 3-year income lost in the intensified program = 94,974,369 baht

Income saved = 165,646,077 baht

Table 4.54 Illustrate income saved when % of deaths = 40% (Currency: baht)

Year 2001: r = 0.03, g = 0.042, per Capita GDP = 80,083 baht per year

Year 2001		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	4,757,263	13	61,844,417	9	42,815,365
15-24	4,226,291	3	12,678,872	2	8,452,581
25-34	3,003,464	3	9,010,392	2	6,006,928
35-44	1,914,384	3	5,743,151	2	3,828,768
45-54	944,421	8	7,555,371	2	1,888,843
55-64	80,884	3	242,651	2	161,768
65+	-	4	-	1	-
Total		37	97,074,854	20	63,154,253
Present value in 2000			94,247,431		61,314,808

Year 2002: r = 0.03, g = 0.042, per Capita GDP = 86,121 baht per year

Year 2002		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	5,115,945	9	46,043,506	9	46,043,506
15-24	4,544,939	3	13,634,818	2	9,089,878
25-34	3,229,916	7	22,609,409	2	6,459,831
35-44	2,058,722	2	4,117,444	2	4,117,444
45-54	1,015,628	4	4,062,511	2	2,031,255
55-64	86,982	4	347,929	2	173,964
65+		2	-	1	-
Total		31	90,815,616	20	67,915,880
Present value in 2000			85,602,428		64,017,230

Year 2003: r = 0.03, g = 0.042, per Capita GDP = 91,100 baht per year

Year 2003		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	5,411,718	11	59,528,902	0	0
15-24	4,807,700	2	9,615,401	0	0
25-34	3,416,650	3	10,249,950	0	0
35-44	2,177,745	3	6,533,236	0	0
45-54	1,074,345	2	2,148,690	0	0
55-64	92,011	2	184,022	0	0
65+		2		0	0
Total		25	88,260,200	0	0
Present value in 2000			80,770,586		0

Total 3-year income lost in current practice = 260,620,446 baht

Total 3-year income lost in the intensified program = 125,332,038 baht

Income saved = 135,288,407 baht

Table 4.55 Illustrate income saved when % of deaths = 50% (Currency: baht)

Year 2001: r = 0.03, g = 0.042, per Capita GDP = 80,083 baht per year

Year 2001		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	4,757,262.82	13	61,844,417	11	52,329,891
15-24	4,226,290.52	3	12,678,872	3	12,678,872
25-34	3,003,464.07	3	9,010,392	3	9,010,392
35-44	1,914,383.83	3	5,743,151	3	5,743,151
45-54	944,421.34	8	7,555,371	2	1,888,843
55-64	80,883.83	3	242,651	2	161,768
65+		4	-	1	-
Total		37	97,074,854	25	81,812,917
	Present value in 2000		94,247,431		79,430,016

Year 2002: r = 0.03, g = 0.042, per Capita GDP = 86,121 baht per year

Year 2002		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	5,115,945.09	9	46,043,506	11	56,275,396
15-24	4,544,939.20	3	13,634,818	3	13,634,818
25-34	3,229,915.58	7	22,609,409	3	9,689,747
35-44	2,058,722.19	2	4,117,444	3	6,176,167
45-54	1,015,627.66	4	4,062,511	2	2,031,255
55-64	86,982.21	4	347,929	2	173,964
65+		2	-	1	-
Total		31	90,815,616	25	87,981,347
	Present value in 2000		85,602,428		82,930,857

Year 2003: r = 0.03, g = 0.042, per Capita GDP = 91,100 baht per year

Year 2003		Current		Intensified	
Age	income foregone	Life lost	Total income lost	Life lost	Total income lost
0-15	5,411,718.37	11	59,528,902	0	-
15-24	4,807,700.34	2	9,615,401	0	-
25-34	3,416,649.94	3	10,249,950	0	-
35-44	2,177,745.17	3	6,533,236	0	-
45-54	1,074,345.17	2	2,148,690	0	-
55-64	92,011.00	2	184,022	0	-
65+		2		0	-
Total		25	88,260,200	-	-
	Present value in 2000		80,770,586		-

Total 3-year income lost in current practice =   260,620,446 baht
Total 3-year income lost in the intensified program =   162,360,874 baht
                                    Income saved =   98,259,572 baht

Table 4.56 An income saved due to death averted from rabies in the intensified
program (discount rate 3%, Currency: baht)

% deaths of initial rate*	Year			Total death	Income saved (baht)
	2001	2002	2003		
20%	10	10	0	20	202,674,911
30%	15	15	0	30	165,646,077
40%	20	20	0	40	135,288,407
50%	25	25	0	50	98,259,272

Note: * Initial rate was 50 deaths in year 2000.
Value in year 2000

4.5.3 Comparison of Benefit / Cost ratio

The sensitive test of changing dog population revealed that an increase in dog population would incur the cost of rabies control and devalue the intensified program. Table 4.57 could be illustrated the result.

Table 4.57 Sensitivity analysis: using expected deaths 20% of the initial rate and changing dog population (Currency: baht)

Dog : Man	Incremental cost*	Incremental benefit	B/C
1:12	-7,363,186	202,674,911	-
1:11	45,954,696	202,674,911	4.41
1:10	109,936,230	202,674,911	1.84
1:9	188,135,828	202,674,911	1.08
1:8	285,885,354	202,674,911	0.71
1:7	411,563,319	202,674,911	0.49
1:6.72	453,455,936	202,674,911	0.45
1:6	579,133,894	202,674,911	0.35
1:5	813,732,726	202,674,911	0.25

Note: * Incremental cost for the 3-year program
Value in year 2000

And the sensitive test of changing a number of deaths during the 3-year of the intensified program was examined by applying 20 – 50% deaths of the initial rate. The range of benefit was 98,259,572 – 202,674,911 baht. Benefit / Cost ratio, when applying different expected deaths 20 – 50%, was showed in table 4.58 – 4.61 and summarized in table 5.62.

Table 4.58 Sensitivity analysis: using an actual number of dog population and changing expected death 20% (Currency: baht)

| Year | Death | | Incremental | Incremental | B / C |
	Current practice	Intensified program	Cost	Benefit	ratio
2001	37	10	8,541,020	65,899,378	7.72
2002	31	10	55,418,948	56,004,947	1.01
2003	25	0	35,361,138	80,770,586	2.28
Total	93	20	99,321,106	202,674,911	2.04

Note: Value in year 2000

Table 4.59 Sensitivity analysis: using an actual number of dog population and changing expected death 30% (Currency: baht)

| Year | Death | | Incremental | Incremental | B / C |
	Current practice	Intensified program	Cost	Benefit	ratio
2001	37	15	8,541,020	47,784,170	5.59
2002	31	15	55,418,948	37,091,320	0.67
2003	25	0	35,361,138	80,770,586	2.28
Total	93	30	99,321,106	165,646,076	1.67

Note: Value in year 2000

Table 4.60 Sensitivity analysis: using an actual number of dog population and changing expected death 40% (Currency: baht)

| Year | Death | | Incremental | Incremental | B / C |
	Current practice	Intensified program	Cost	Benefit	ratio
2001	37	20	8,541,020	32,932,623	3.86
2002	31	20	55,418,948	21,585,198	0.39
2003	25	0	35,361,138	80,770,586	2.28
Total	93	40	99,321,106	135,288,407	1.36

Note: Value in year 2000

Table 4.61 Sensitivity analysis: using an actual number of dog population and changing expected death 50% (Currency: baht)

| Year | Death | | Incremental | Incremental | B / C |
	Current practice	Intensified program	Cost	Benefit	ratio
2001	37	25	8,541,020	14,817,415	1.73
2002	31	25	55,418,948	2,671,571	0.05
2003	25	0	35,361,138	80,770,586	2.28
Total	93	50	99,321,106	98,259,572	0.99

Note: Value in year 2000

Table 4.62 Sensitivity analysis: Summarized B/C when changing expected deaths in
the intensified program (Currency: baht)

Expected deaths	Incremental cost	Incremental benefit	B / C
20%	99,321,106	202,674,911	2.04
30%	99,321,106	165,646,076	1.67
40%	99,321,106	135,288,407	1.36
50%	99,321,106	98,259,272	0.99

Note: Value in year 2000
Discount rate 3%

4.6 Discussion

The study showed that total cost of rabies control in year 2000 was 1,188,446,635 baht. When comparing cost of human PET to dog rabies control, it was found that total cost of human PET was 808,178,253 baht while the other one was 380,268,382 baht. The higher in PET was 427,909,871 baht or 112.5%. The researcher could not compare this result to another study due to no study of cost analysis of rabies before. We should recognize that dog is actually a major source of spreading but receiving fewer budgets than human treatment. The implication is that nowadays we are solving the tail end of problem. If we cannot prevent a dog to bite a man, it is better to prevent a dog from contracting rabies. Certainly, by this way an exposed person will not contract the disease.

Comparisons the cost of 3 activities spent on controlling rabies in dog, it was as follows:
(1) Cost of dog was the highest or equal to 199,108,429 baht. Average cost was 46.54 baht per vaccination (range 35 – 92.68 baht). This activity done by BMA is the most expensive or equal to 92.68 baht; because of a very high fixed cost, and done by LGA is the cheapest. But we should aware of limitation because LGA's expense was an operating cost not full cost of activity.
(2) Cost of other programs, as its definition had been mentioned before, it was a combination of reproduction control and other related campaigns, particularly worked for dog control. Total cost was 169,499,531 baht. The researcher did not analyze its unit cost owing to many details of reproduction control methods and time limitation. Though the result was consistent to the actual practice. The highest expense was occurred at veterinary private clinic. Because the biggest part of dog population was owned dogs [9] and the owners mostly brought them to receive care at private clinics.
(3) Cost of laboratory diagnosis in animals was the lowest or equal to 11,660,422 baht. Average cost was 2,897.72 baht (range 1,365.29 – 4,158.92 baht). This was done by DLD showing the expensive price because of having many centers to provide a service (23 centers across country) but producing inappropriate output to its scale. Meanwhile, investigation done by QSMI was the cheapest price because of having only one center in Bangkok.

The last activity to be considered is human PET, which consists of PEV, rabies treatment, complication treatment and laboratory diagnosis in human. Total cost was 808,178,253 baht or 480.08 baht per visit. Certainly, cost of care provided by private hospital was very high but vaccinee numbers at public hospital was more than the former. We should aware of the cost occurred at public hospital, it was an operating cost. Supposing true unit cost of vaccination of public hospital was close to QSMI, the answer would be the public hospital spending a very huge amount or two times higher (672,070,783 baht / 335,091,305 baht). Another limitation of the study was that, however, total cost of private hospitals might incur a very high amount beyond the fact. It was particularly due to calculate their cost from the remaining vaccines after less the total imported vaccines from the quantity consumed by public hospital.

It could be observed from data that PEV had been increasing every year and rapidly projected for a few year ago. Rate of PEV in 1991 was 1,653 per million populations. Records in 1999, 2000 were 3,887 and 5,501 per million populations respectively. The update one in 2001 was 5,635 per million populations. There are many factors having influence on rising numbers [12] such as an effect of health education disseminating continuously, the modern safety and potent vaccine which was lower number of doses and cheaper than before. Especially, present government is running the national health insurance (30-baht scheme for all disease). It will be the hidden burden of government expenditure for present and future unless appropriate measure is to restrain the cost as what was happened to the CSMBS.

Additionally, lab investigation for human rabies confirmation was done at very low numbers. [28] Most of patients were diagnosed by clinical sign and symptom while having some patients of Dumb rabies be missed diagnosed. Confirmation by lab would prevent such problems. Not only was the proper diagnosis but also the strengthened surveillance would be the benefit. Nowadays rabies surveillance is dependent on lab diagnosis very much. The same thing should be happened in lab diagnosis in animals too. Unless the true situation of rabies did know, the proper measure and planning would be done misleadingly.

Dog population surveyed by National Statistical Office and Bureau of Health, BMA in year 1999 was found that there were totally 633,814 dogs in Bangkok vicinity and 110,584 ownerless (stray) dogs or approximately 17.5%. So, owned dogs were 82.5%. Result of this survey the researcher can assume that owned dogs were 80% in Thailand. The study found a number of dog vaccinations at private clinics approximately 1,468,206 dogs or 24.5% of total dog population (5,987,195 dogs). That meant some of owned dogs (55.5%) received free vaccines from public sector. These were the burden of government to spend on vaccination. Expenses were implicitly shifted to government instead of the owner. Actually, public sector should try to vaccinate stray dogs as much as possible and let the owners be responsible for their pets. By the way, law enforcement will be needed in the long run.

Results of estimating the three-year expense, the current practice = 3,801,275,367 baht and the intensified program = 3,900,596,473 baht, were showed that the latter was certainly higher than the former approximately 99,321,106 baht. The extra money was to spend on dog vaccination so as to provide coverage not less than 80% of dog population. The returns of program were the reduction of deaths. At the end of three-consecutive years, it was expected to reduce 27 deaths in the 1st year, 21 deaths in the 2nd year and 25 deaths in the 3rd year, mostly in children below 15 years of age.

The researcher applied Human Capital Approach and average income of Thai people; per Capita GDP, economic growth during 2000 – 2003; approximately 4.2%, to evaluate human life into monetary value. With a discount rate 3%, an income foregone being saved was 202,674,911 baht and with a discount rate 5%, an income foregone being saved was 134,893,373 baht. Benefit-Cost ratio (B/C) of both estimates was 2.04 and 1.36 respectively.

Sensitivity analysis was also tested by increasing dog population (cost increased) and reducing benefit (increased number of deaths in the intensified program). From table 4.57, when dog population was increased, or dog to human ratio was below 1: 9 (e.g. 1: 8, 1: 7), it would not be cost-benefit. However, current data showed that dog to human ratio was approximately 1:10.3.

And also death numbers of the intensified program were examined. On the assumption of Bogel K (1990), it was expected to have deaths 20% of the initial rate. Sensitivity analysis was done by changing deaths (reduced benefit) from 20 – 50% of the initial rate in the first year and the second year. Results were presented in table 4.58 – 4.62. With a discount rate 3%, number of deaths varied from 20%, 30%, 40% and 50%, B/C ratio would be 2.04, 1.67, 1.36 and 0.99 respectively.

In conclusion, the intensified program was possibly cost-benefit to implement, when considering on societal perspective.