CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 HRIG Direct Cost: Production Cost

Product Specification

Thai Red Cross Society Human Rabies Immunoglobulin (TRCS-HRIG)

TRCS-HRIG is the purified and concentrated antibody which is obtained from hyperimmunized plasma donors who are immunized with rabies vaccine.

Composition: 1 milliliter of TRCS-HRIG contains 150 international units (IU). Protein 16.5 ± 1.5 % in 0.3 molar of Glycein solution, pH 6.Thymerosan is used as preservative. This HRIG is precipitated to distinguish the nongammaglobulin composition follow Cohn's Method.

Storage: Keep TRCS-HRIG at 2-8 degree Celsius. Do not freeze.

Dosage: 20 units per Kg. Half of immunoglobulin is injected around the wound and the other half is injected intramuscularly.

Physical property	: slightly opalescent solution
pH	: 6.4-7.2
Protein content	: 10-18 gm%
Purity	: more than 90% immunoglobulin G
Stabilizing agent	: Glycine 0.3 mol/L
Preservative	: Thimerosal 0.01%
Absence of HBs-Ag and HCV	
Absence of HIV	
Sterile	
Apyrogenic	
Non toxic	

Production Process of HRIG

- Selection of volunteers
- Immunization
- Collection of plasma
- Fractionation procedure
- Preparation of final product
- Quality control

Selection of volunteers

The volunteers are from normal individual who are immunized with rabies vaccine.

Immunization schedule

The donors will be immunized with TRCS-Verorab. The dose of injection is 0.1 ml. Rabies vaccine is injected intradermally at deltoid region of both arms on day 0. The immunization will be repeated at day 7 and day 21.Booster dose will be given 2 weeks to 1 month before plasma donation.

Collection of plasma

The donors can donate their plasma as routine as blood donors for every 3 months. The quantity of plasma per donation is about 200-250 ml.

Plasmapheresis is another option and the most common method to collect hyperimmunized plasma. With this method, the donors can donate as frequent as every month. The quantity of plasma, which is obtained from this method, is about 500 ml.

Fractionation procedure

The whole plasma will be fractionated follow Cohn's method with the cold ethanol. With this method, the protein in plasma will be precipitated. This procedure will fractionate the protein into five important variables (fraction). The factors that distinguish the variables are

1. Ethanol concentration
2. Temperature
3. Protein concentration
4. Ionic strength
5. pH

Quality control

The quality control is strictly performed in every procedure to ensure the quality of product before and after the final product is finished and before distribute as well. The quality controls include:

- Sterilization
- Absence of hepatitis B virus
- Absence of hepatitis C virus
- Absence of HIV
- Effective titer of immunoglobulin
- Total protein
- pH

The schemes below show the process of preparing ERIG.
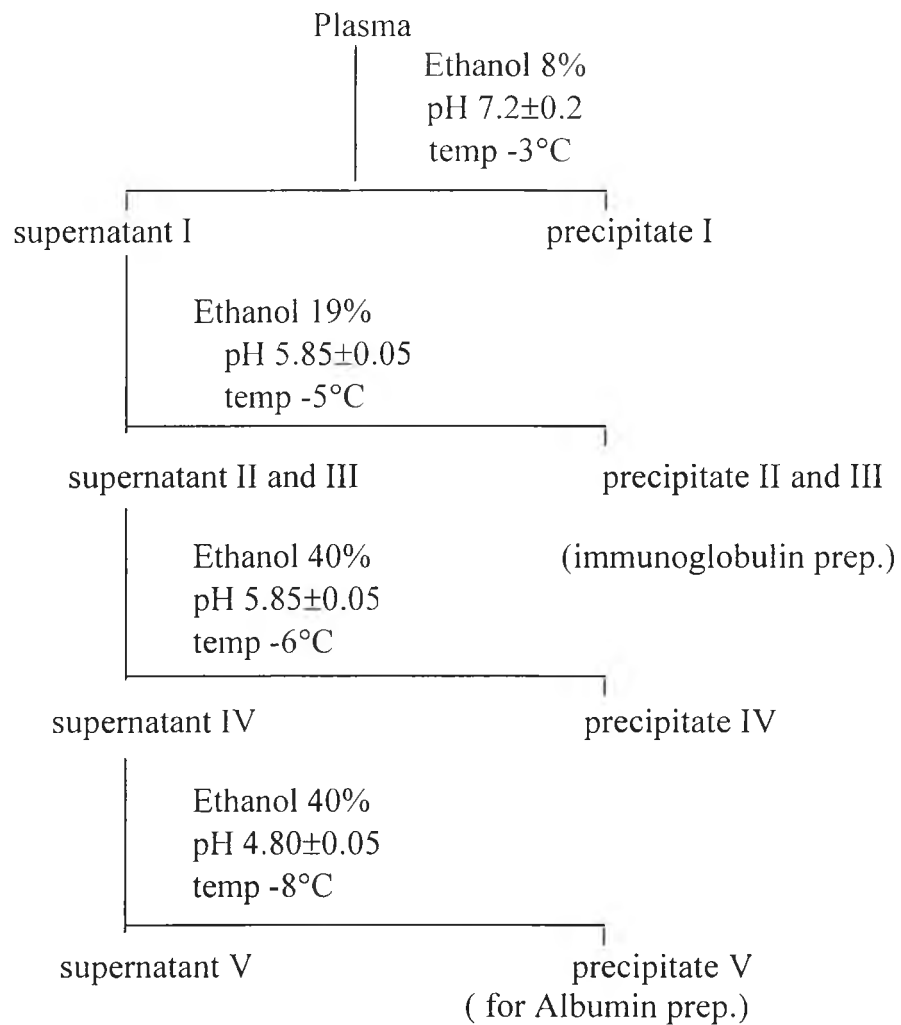
Plasma Fractionation Scheme

Plasma
Ethanol 8%
pH 7.2±0.2
temp -3°C

supernatant I   precipitate I

Ethanol 19%
pH 5.85±0.05
temp -5°C

supernatant II and III   precipitate II and III

Ethanol 40%   (immunoglobulin prep.)
pH 5.85±0.05
temp -6°C

supernatant IV   precipitate IV

Ethanol 40%
pH 4.80±0.05
temp -8°C

supernatant V   precipitate V
                                     (for Albumin prep.)

Figure 4.1: This scheme shows how to obtained the "precipitation II" or the intermediate product-I. This intermediate product will be undertaken in next process in order to get "precipitate II-C" or the intermediate product-II

Preparation of Precipitate IIC (intermediate product)

Precipitate II+III

|

Dissolve in distilled water

Suspension

|

pH 4.8±0.05
temp. ±2°C

|

pH 5.10±0.05
ethanol 12%
temp. -5°C

|

supernatant IIA   precipitate IIA

| pH 7.0±0.1
| ethanol 30%
| temp -6°C

supernatant IIC   precipitate IIC (gamma-
                                         globulin)
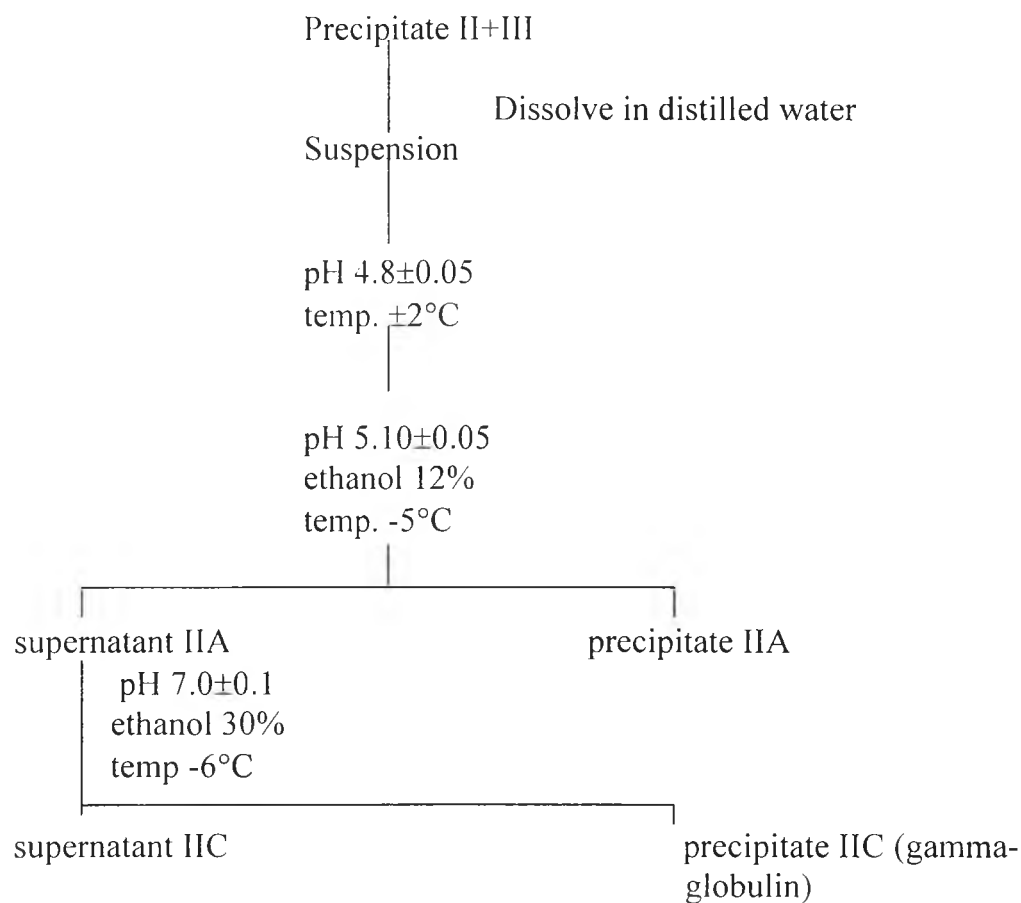
Figure 4.2: This scheme shows the process of getting " precipitated II-C" from "precipitate II"

Preparation of HRIG

Precipitate IIC

| Dissolve in distilled water

Filtration

|

Lyophillization

|

Dissolved with stabilizer (0.3M glycine)

|

Add preservative (0.01% Thimerosal)

|

Filtration
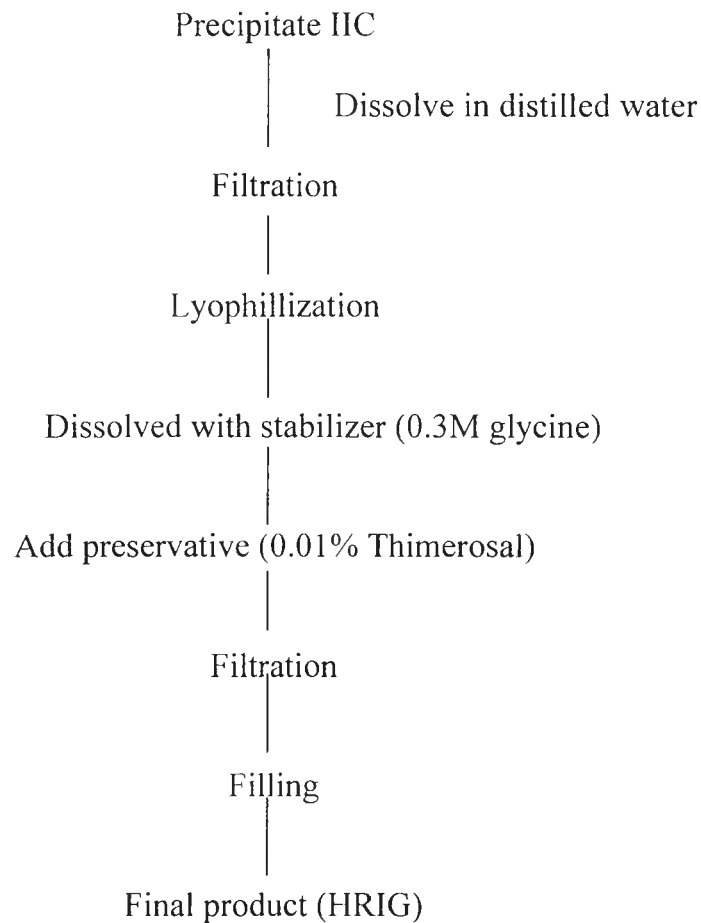
|

Filling

|

Final product (HRIG)

Figure 4.3: This scheme shows the final process of preparing HRIG from "precipitate IIC" or intermediate product-II

Source: Manual Procedure of ERIG Production, National Blood Bank, Thai Red Cross Society

Remark

- The sequences and procedures of preparing HRIG and HBIG are generally the same.

- The cycle of processing HRIG and HBIG since obtaining the plasma until getting the final product is equal. It will take 435 hours each.

- Working hour of preparing albumin (another final product which is not show the scheme here) is equal to 35 hours.

- This working hour of HRIG, HBIG and albumin is not included the time in processing the quality control.

Efficacy Quality Controls

As recommended by WHO (1981) and European Pharmacopoeia (1987), there are factors which determine the efficacy of the product, and the production plant must follow strictly.

1. Protein concentration
2. Purity
3. Hydrogen ion concentration
4. Sterility
5. Freedom from undo toxicity and pyrogen
6. Stability
7. Potency
8. Proportion of aggregated and fragmented immunoglobulin

HRIG production cost

From the data of HRIG production from TRCS, there are 2 units those involve in HRIG production. They are

1. Plasmapheresis unit: this unit is about how to obtain the hyperimmunized plasma from the donors
2. Plasma unit: this unit is about how to obtain the final product-rabies immunoglobulin- from the plasma. This unit involves with precipitating, freezing and containing since the intermediate product until getting HRIG.

Cost of plasmapheresis unit

This unit is used to extract merely plasma directly from the donors. The red blood cell, white blood cell and platelet will not be removed from the donors. This unit sharing its cost with the Hepatitis immunoglobulin, as a result that, this unit is not only used for preparing rabies immunoglobulin but it is also used for preparing hepatitis B immunoglobulin. Hence, the cost that incurs in this unit should be share with these two outputs.

According to the data in year 2000 from TRCS, there were 1,696 (68 %) donors came to donate their plasma for HRIG and 803 (32%) donors for hepatitis immunoglobulin. Total donors were 2,499. Thus, the cost of plasmapheresis unit will be allocated due to the weight of number of the donors for the specific product.

Table 4.1: Cost of HRIG production, National Blood Bank, TRCS, 2000.

Unit	Capital depreciation cost	Logistic supply cost	Labor cost	Utility cost	Administra-Tive cost
Plasmaphere-sis	2,041,266.40	2,695,941	185,068	728,791.05	1,866,581.34
Precipitation	1,080,241	1,161,999.20			
HRIG containing	349,460.50	100,364.58	728,819.7	2,068,417.43	3,154,596.64
Subtotal	3,470,967.90	3,958,305	913,888.7	2,797,208	5,021,177.98
Total (baht)					**16,161,547.58**

Source: Department of Administrative, National Blood Bank, Thai Red Cross Society, 2000

Cost of plasma unit (for plasma precipitation and containing)

After getting the hyperimmunized plasma from the plasmapheresis unit, the next step is to precipitate the hyperimmunized plasma to obtain the intermediate product-precipitate P IIC. Then, this intermediate product will be undertaken in processing to get the final product-HRIG.

From the total cost in Table 4.1, this cost must be added with other accessory costs, which are not shown in table 4.1, to retrieve the final HRIG production cost.

Other accessory cost:

1. Cost of donor's laboratory testing = 474,880 baht (280 baht per donor)
2. Cost of machine fixation = 129,815.49 baht
3. Cost of durable articles in plasma unit = 806.514 baht

The total cost of HRIG production was = 17,576,757.07

Remark:
- The building cost is not included in the cost calculation in year 2000 because this production plant uses the old building which is last over 20 years.
- This calculation excluded the cost of the capital that is last over 10 years.
- The administrative cost is allocated due to the number of the personnel in each department.
- The labor cost was allocated to plasma unit due to the work hour of staff spending for preparing HRIG. This cost must be shared with HBIG and albumin.
- This total cost does not include the cost of quality control.

4.2 ERIG Direct Cost: Production Cost

Production Process of ERIG

The production process of ERIG and HRIG is nearly the same except that the plasma for extracting ERIG is from horse (equine) but another is from human.

One of the most distinctive differences of production cost between HRIG and ERIG is that ERIG incurs the cost of raising horses to obtain hyperimmunized plasma. In this calculation, the cost of raising horses will be use as the cost of raw material (cost of the plasma). In year 2002, TRCS aims to produce 100,000 vials of ERIG. The cost per vial is show below in table. TRCS invested in this production plant as much as 171,440,675 baht.

Table 4.2: Cost per unit of ERIG, National Blood Bank, TRCS, 2000

Item	Cost (bath)
Plasma	80
Raw material	36
Packing materials	10
Own department expense	31.75
Electricity	4.54
Water, post, phone, etc	2
Administrative cost	5.6
Quality assurance cost	5.05
Transportation cost	7
Depreciation cost	84.4
Insurance cost	1
Total cost	**267.34**

Source: Administrative Department, Queen Saovabha, Thai Red Cross Society, 2002

Total direct cost of ERIG production

The total direct cost of ERIG production is 267.34×100,000

=26,734,000 baht

4.3 HRIG Indirect Cost

Income forgone due to shortage of HRIG

In year 2000, TRCS produced HRIG 3,651 vials of HRIG which was enough for 3,651 patients (1vial contains 1,000 IU and dose of HRIG for injection is 20 IU/Kg, for 50-kg individual uses 1 vial per dose). If we used strictly only HRIG, there would be shortage of rabies immunoglobulin and this incurred cost of life that being loss according to this shortage.

Life loss due to the shortage of the rabies immunoglobulin can be calculated from the formula below.

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

- This calculation uses GDP per employment to represent I. This study aims to identify the productivity loss due to rabies occurrence. According to the imperfect information in the Labor market, the wage rate of the worker does not represent the productivity that generate form worker. The wager rate usually lower than real productivity in each worker. Even in the perfect competition market, the wage rate is equal to the last marginal benefit of the last worker. Hence, this study uses GDP per employment to as I in calculation of income foregone loss. The average of GDP over the period of year 1997 to 2001 is 4,799.08 billion baht. And the average of employment rate from year 1995 to 2001 was

30.96 million. Thus, the GDP per employment was equal to 155,009 baht per year (See table 4.3)

However, this study will use wage rate as well to compare simultaneously. This wage rate was used to identify the income loss of the labor force. According to the Labor Protection Act'2001, the minimum wage rate is 130 baht per day. With the 320 workdays a year, the minimum wage rate is 41,600 baht per year.

- From the equation above, g refers to the income-increasing rate. Usually we use the growth rate of GDP, but the rate of GDP was fluctuated over the last 7 years. There was a sharp increase of GDP in year 1993 to 1996 and then decline due to the economic crisis in year 1997. In this study will use the average GDP growth rate during the year 1993-2001.

Table 4.3: GDP and Employment Rate in year 1995 to 2001,Bank of Thailand, 2002 [27]

Year	1995	1996	1997	1998	1999	2000	2001
GDP (billion baht)	4,192.7	4,622.8	4,732.6	4,626.4	4,632.1	4,904.7	5,099.6
Employed (million)	30.82	30.98	31.52	30.10	30.66	31.29	31.65

*GDP in year 1993 was 3,170.3 billion baht.

Source: Annual Report of Thailand Economic indicators, Bank of Thailand. 2002

- Average GDP growth is calculated from the total growth of GDP from 1993 to 2001. This study does not use the growth rate just after year 1997 because it will be negative according to the fact that there was the economic crisis in Thailand and South East Asia. The growth rate reflects to the investment of human resource. In this case, the rate should not be negative.

$$(1+g)^8 \times 3{,}170.3 = 5{,}099.6$$

$$1+g = \frac{(5{,}099.6)}{3{,}170.3}^{1/8}$$

$$g = 0.061$$

Thus this study uses the instant GDP growth rate at 6.1% per year to represent g

Table 4.4: Fixed Deposit Interest Rate (1 yr.) and Prime Interest Rate Year 1997-2002, Bank of Thailand, 2002[27]

Year	1997	1998	1999	2000	2001	2002
Fixed deposit interest rate (1 yr.) (%)	13	6	4.25	3.5	3	3
Prime interest rate (%)	15.25	11.2	8.5	8.25	7.5	7.25

Source: Annual Report of Thailand Economic indicators, Bank of Thailand. 2002

- Value of r is usually lower than that of g. if r (discounting factor) is greater than g (income increasing rate), the return of the income per year will be decreasing every year. According to the fact that when the people grow up, as in human capital approach, their productivity must increase rather than decrease. Additionally, most of the studies use interest rate to represent r. From the table below, the average prime interest rate during 1997 to 2002 is 9.66%. If this study uses r= 9.66%, it

will violate the fact that discussed above. Thus, this study uses the average fixed deposit interest rate of 1 year to refer to r which is equal to 5.46%

Table 4.5:The Income Forgone in Each Age Group and the Total Income Foregone. (r =5.46%,g =6.1% and Wage Rate =41,600 Baht per Year)

Age group	Income forgone (baht)	Number of death	Total income loss (baht)
3+	2,309,978.99	1	2,309,978.99
4+	2,309,978.99	1	2,309,978.99
5+	2,309,978.99	0	0.00
6+	2,309,978.99	3	6,929,936.97
7-9	2,309,978.99	1	2,309,978.99
10-14	2,309,978.99	5	11,549,894.95
15-24	1,956,587.00	9	17,609,283
25-34	1,439,272.00	6	8,635,632
35-44	952,328.20	8	7,618,625.6
45-54	493,972.40	3	1,481,917.2
55-64	41,726.23	7	292,083.61
65+	0	6	0
Total			61,047,310.3

From the table 4.5 and 4.6, the total income forgone loss is much different; this is because of the difference in I. As mention earlier, the wage rate at 41,600 baht per year is not a good representative of I. At this step, it is believed that GDP per employed should be used instead of the minimum wage rate. The total income forgone is equal to 283,258,187.4 baht.

Table 4.6: The Income Forgone in Each Age Group and the Total Income Foregone. (r =5.46%,g =6.1% and GDP per Employed = 155,009 Baht per Year)

Age group	Income forgone (baht)	Number of death	Total income loss (baht)
3+	8.607,392.6	1	8,607,392.6
4+	8,607,392.6	1	8,607,392.6
5+	8,607.392.6	0	0.0
6+	8,607.392.6	3	25,822,177.9
7-9	8.607.392.6	1	8,607,392.6
10-14	8,607,392.6	5	43,036,963.2
15-24	7,290,592.0	9	77,466,533.7
25-34	5,362,984.0	6	43,743,552.0
35-44	3,548.544.0	8	42,903,872.0
45-54	1,840,629.0	3	10,645,632.0
55-64	155,479.3	7	12,884,403.0
65+	0.0	6	932,875.8
Total			**283,258,187.4**

*The age of calculation income forgone is between 13 to 60

- Sensitivity test is performed in this study to understand the effect of change in various discount rates; the study uses 6, 7 and 8% to represent the discounting rate (r).

Table 4.7: The Income Forgone in Each Age Group and the Total Income Foregone. (r =6%,g =6.1% and GDP per Employed = 155,009 Baht per Year)

Age group	Income forgone (baht)	Number of death	Total income loss (baht)
3+	7,607,796.6	1	7,607,796.60
4+	7,607,796.6	1	7,607,796.60
5+	7,607,796.6	0	0.00
6+	7,607,796.6	3	22,823,389.80
7-9	7,607,796.6	1	7,607,796.60
10-14	7,607,796.6	5	38,038,983.00
15-24	6,557,325.0	9	68,470,169.40
25-34	4,953,706.0	6	39,343,950.00
35-44	3,365,137.0	8	39,629,648.00
45-54	1,791,477.0	3	10,095,411.00
55-64	155,082.1	7	12,540,339.00
65+	0.0	6	930492.60
Total			254,695,772.60

Table 4.8 The Income Forgone in Each Age Group and the Total Income Foregone. (r =7%,g =6.1% and GDP per Employed = 155,009 Baht per Year)

Age group	Income forgone (baht)	Number of death	Total income loss (baht)
3+	6,142,712.80	1	6,142,712.80
4+	6,142,712.80	1	6,142,712.80
5+	6,142,712.80	0	0.00
6+	6,142,712.80	3	18,428,138.40
7-9	6,142,712.80	1	6,142,712.80
10-14	6,142,712.80	5	30,713,564.00
15-24	5,449,176.00	9	55,284,415.20
25-34	4,305,175.00	6	32,695,056.00
35-44	3,060,344.00	8	34,441,400.00
45-54	1,705,796.00	3	9,181,032.00
55-64	154,357.10	7	11,940,572.00
65+	0.0	6	926,142.60
Total			212,038,458.60

Table 4.9: The Income Forgone in Each Age Group and the Total Income Foregone. (r =8%,g =6.1% and GDP per Employed = 155,009 Baht per Year)

Age group	Income forgone (baht)	Number of death	Total income loss (baht)
3+	5,052,445.48	1	5,052,445.48
4+	5,052,445.48	1	5,052,445.48
5+	5,052,445.48	0	0.00
6+	5,052,445.48	3	15,157,336.44
7-9	5,052,445.48	1	5,052,445.48
10-14	5,052,445.48	5	25,262.227.40
15-24	4,592,648.00	9	45,472,009.32
25-34	3,773,359.00	6	27,555,888.00
35-44	2,794,950.00	8	30,186,872.00
45-54	1,626,516.00	3	8,384,850.00
55-64	153,645.50	7	11,385,612.00
65+	0.0	6	921,873.00
Total			179,484,004.60

From the sensitivity analysis above, the cost of life loss or income forgone varies from 179,484,004.60 to 254,695,772.60 baht. This is due to the different rates of r. However, the costs of life loss from 3 values of r are still the major part of indirect cost and do no affect the result of this study.

According to the report from Department of Communicable Disease Control, MOPH, the number of exposure was 356,279 patient with 50 mortality case (one death case was treated with ERIG, and 49 cases did not received either ERIG or HRIG). Rabies immunoglobulin was used in 21,296 patients (17,654 of ERIG and 3,651 of HRIG). If we strictly use only HRIG, in year 2000, there would be 17,654 cases more those received no immunoglobulin. The number of patient would be increase.

The expected number of patients

$$\frac{352,637}{334,983} \times 50 = 51.58 \cong 52 \text{ cases}$$

The expected cost of possibly 52 cases

$$283,258.187.4 \times \frac{52}{50} = 294,588,514.9 \text{ baht}$$

We assume that the behavior of the disease, dogs, people, patients and doctors and other things are holding constant. Thus, the calculation can use the previous incidence to predict the number of the patients.

Since the MOPH propose that there should be at least of 100,000 of ERIG produce every year (for about 50,000 patients), with constrain in production of HRIG, the shortage occurs. Then, the number of rabies cases would be risen more than 52 cases and the cost of income forgone as well.

Cost of possibly rabies occurrence

DRG (diagnosis related group) and RW (relative weight)

DRG is the patient classification system. This system is used to classify the inpatient to predict the cost of treatment per individual inpatient or even length of stay of the patient. This system is more precise than other classification system. The patients in the same group will have cost and length of stay close to each other.

Relative weight is the one of the most important parts in health system and health care financing, it tells the comparative weight of the particular disease with the average weight of overall disease. Thus. there must be the calculation of 1 unit of RW or 1 RW in to money term to get the cost per 1 RW. For example. 1RW in year 2000 was equal to 4,000 baht.

There are 2 kinds of mean to calculate the RW. One is arithmetic mean and another is geometric mean. In this study used the arithmetic mean to calculate cost per 1 RW.

Arithmetic mean relative weight

$$RW = \frac{\text{Arithmetic mean of cost for that DRG}}{\text{Arithmetic mean of cost for all patients}}$$

Table 4.10: The Cost of Rabies Treatment in 52 Expected Cases

Disease	ICD10	DRG	RW	Number of patients	Cost (bath)
Rabies	A52	423	1.226	52	255,008

Source: Health Insurance Office, MOPH

Cost of complication

In year 2000, there was no report of the adverse reaction due to HRIG use. Thus, in this calculation, the cost of complication is not added.

Total indirect cost of HRIG

The total cost of rabies is derived from the income forgone and cost possibly rabies occurrence. Hence, the total indirect cost of HRIG was 294,843,522.90 baht.

4.4 ERIG Indirect Cost

Complication cost due to ERIG use.

ERIG is the product which obtained from hyperimmunized plasma of horse. Almost all of the standard production plants try to purify the protein component in this product as much as possible to lower the possibility of adverse product reaction (APR). However, there are still the chances of adverse reaction occurrence. The adverse reactions from the ERIG use include anaphylaxis, serum sickness, urticaria, angioedema and etc. These complications have wide range of degree of severity. Some are minor such as urticaria or rash and some are life threatening.

Table 4.11: Report of Adverse Product Reaction Surveillance, Thai FDA, MOPH, 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	IPD
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, MOPH.

In 2000, the adverse reaction after ERIG use had been reported to the Division of Adverse Product Reaction Surveillance, Thai FDA, Ministry of Public Health (See table 4.11). In 2000, the adverse reaction after ERIG use had been reported to the Division of Adverse Product Reaction Surveillance, Thai FDA, Ministry of Public Health (See table 4.11).

According to the report above, the number of patients with complications is perhaps under report because of the problem of information technique and system in Thailand. However, there was no serious complication of the ERIG use (such as serum sickness or anaphylaxis). Thus, the complication cost was trivial when compare with the other cost.

These complications those we observed above can be converted into monetary cost by using the DRG (See table 4.12).

Table 4.12: DRG and Relative Weight (RW) of the Adverse Reaction, DRG Tools Book, MOPH, 2000.

Disease	ICD10	DRG	RW	Number of patients	Cost (bath)
Asthma	J45	98	0.4721	2	3776.8
Periorbital edema	H052	45	0.83	1	3320
Rash	R21	284	0.6454	4	10326.4
Urticaria	L50	284	0.6454	3	7744.8
Total					**25,168**

Source: Health Insurance Office, MOPH

Remark

- Cost of each disease is calculated from RW×4,000×number of patients
- Asthma refers to the group of the disease of bronchospasm and dyspnea
- Asthma in this table refers to the asthma without complication
- Erythematous rash and urticaria have the same DRG and RW

- The study uses the cost from DRG-IPD patient as the standard cost in this calculation.

The cost of complication will be higher if we use more ERIG. There were 10 cases with complication after 17,645 patient use. If there were 21,296 patients (total number of patient who received rabies immunoglobulin) uses, there would be $\cong 12$ cases. If there were 50,000 patient use (expected annual use by the MOPH), there would be 28.336 $\cong$ 28 cases

Then, cost of complication of possibly complication occurrence would be

$$25,168 \times \frac{12}{10} = 30,202 \text{ baht}$$

Cost of possibly rabies occurrence due to ERIG use

From the data from the CDC, MOPH, 11-year boy died from rabies in spite of ERIG treated. Since ERIG and HRIG have the same efficacy to prevent rabies, so that, the occurrence of rabies in this boy could be considered as cost common to both ERIG and HRIG. In addition, the death might arise from the technique of injection, inadequate doses or other things else. The cost dues to rabies occurrence both costs of treatment and income forgone will not be added in the calculation ERIG of indirect cost.

Cost of shortage

According to the new production plant of ERIG, there will no longer be the shortage of ERIG; this new plant site can maximize the output to meet the need of ERIG in Thailand and for the neighbor countries as well. In the year 2002, TRCS aims to produce 100,000 vials of ERIG. This number is from the

estimation by MOPH that there will be 50,000 patients who need rabies immunoglobulin.

Total indirect cost of ERIG

The main consideration of indirect cost of ERIG arises from complication. From the calculation above, the total indirect cost was 58,757,809.34 baht.

4.5 Total Cost and Cost per Unit of ERIG and HRIG

The total cost of both ERIG and HRIG is from the summation of direct and indirect cost. The total cost of them is shown below.

Table 4.13: The Total Cost and Cost per Unit of ERIG and HRIG

Type of RIG	Direct cost	Indirect cost	Total cost	Volume of production	Unit cost
HRIG	17,576,757.07	294,843,522.90	312,420,279.97	3,651	85,571.15
ERIG	26,734,000	30,202	26,764,202	100,000	267.64202

4.6 Discussion

According to the table 4.13, the total cost of HRIG (both direct and indirect cost) is much larger than cost of ERIG and the cost per unit as well. The cost per unit of ERIG and HRIG is hardly comparable. The cost per unit of ERIG is 267.55 baht and 85,571.15 baht for that of HRIG. The total cost of HRIG is 15 times higher than that of ERIG, but the cost per unit of HRIG is nearly 300 times difference.

One of largest cost of HRIG is the income forgone due to possibility of rabies occurrence in case that we strictly use only HRIG. This cost accounts for almost 90% of the total cost. ERIG also has the important indirect cost that is cost of complication due to ERIG use because ERIG is derived from horses; there is the possibility of complication such as allergy, rash or even anaphylaxis. But for this animal product, the complications seem to happen less than we expect. This cost is very trivial and does not affect much to the total cost of ERIG.

The indirect cost reflects costs of health. This study uses the formula of summation of income forgone loss and adjust with growth rate and discount rate to calculate the cost of life loss. The approach to state of good health can be use in many ways. The previous study of Liu J. (2000) and Ried W. (1996) used willingness to pay approach to reveal the cost of health. Johnson F. (2000) defined health as commodity and use stated-preference approach to find out cost of good health.

Another factor to keep in mind is that cost should be discount as well as the benefit or not. Gravelle H. (1998) suggested to discount both. This study adjusts rate of change over years only for benefit.

Indirect cost still the major cost even in case that we ignore the indirect cost of HRIG; the cost per unit of HRIG will be equal to 4,814.2 baht.

$$\frac{17,576,757.07}{3,651} = 4,814.2 \text{ baht}$$

Thus, The choice that we made according to the cost per unit is still the same.

Another factor that brought the unit cost of ERIG down was the estimated volume of production. TRCS aims to produce ERIG at least 100,000 vial this year. This volume can be used in about 50,000 patients. This number of estimation is somewhat lower than the real production potential of this new plant.

According to the standard regimen of rabies prophylaxis, rabies immunoglobulin should be given to all exposure patients except when the individual has previously received pre-exposure prophylaxis and as soon as possible. Consequently, there should be higher volume of production. When volume of production is larger. the cost per unit is cheaper (economic of scale). Hence, TRCS can produce at large amount of ERIG to supply in Thailand.

The international market of rabies immunoglobulin is the important market as well. In Southeast Asia region, there are only 3 countries those can produce rabies immunoglobulin. They are Thailand, Vietnam and Indonesia. Nevertheless, the other 2 countries do not have plants to produce as export goods. Their demands in the countries need to be subsidized form the import. This would be the other channel to manage with the high production volume of TRCS.

From this analysis, we found that Thailand cannot rely on only HRIG because of its constrains of cost and the production potential. The shortage of rabies immunoglobulin without other substitution incurs in a great deal of cost such as cost of life that being loss. As a result, ERIG is considered to be more cost-effectiveness to be used in Thailand when it is compared with HRIG despite the chance of its complication occurrence.