

## CHAPTER 2

### CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

#### Definition of Costing

There are two different ways to analyze the cost of activities undertaken by an intervention: using financial costs and using economic costs.

Financial costs are a useful first step to derive economic costs and also provide an indepth understanding of money flows and who pays. They provide an overview of the financial resources required for the intervention, the extent to which budgets have been actually utilized.

Economic cost estimates are the ones used in combination with effectiveness estimates to make judgements about the efficiency of the intervention and the scope for improvement.

**Table 2.1 The difference between financial and economic cost**

	Financial costs	Economic costs
Description	Expenditure on the intervention	Value of the opportunities lost in employing resources in the intervention
Costs included	Inputs purchased	All resources employed in the intervention including voluntary labor
Valuation	Market price of purchased goods	"Shadow prices" are employed if market do not reflect the "Opportunity cost" of resources.
Perspective	Can be any defined individual or organization	Usually a societal perspective Ideally customer costs should also be included.
Purpose	Shows the funds required to cover costs and whether the intervention is affordable.	Shows (together with measures of effectiveness) whether the intervention is efficient.

In economic terms, cost may include expenditure on the activity (financing costs) together with revenue foregone or opportunity cost (the highest valued opportunity necessarily forsaken) (Kaewsonthi, S. et al, 1983).

Usually cost represents the resources given up in a particular situation in order to carry out an activity, normally expressed in term of money.

### **Cost Classification**

From the economist point of view, cost means the total resources consumed for a specific activity. When making the cost analysis, therefore, it is important to include all the inputs and the cost items in the analysis. Usually, the first step is to identify the cost categories which should be included. Classification of cost elements can be done by several ways. Whatever the method is followed, it is essential to consider three aspects. A good classification includes relevance of classification to the particular situation, no overlapping between classes and covering all possibilities by the classes chosen (Creese and Parker, 1994).

Costs can be classified into difference group depending on the basis of classification (Figure 2.1).

1. Classified by costs incurred: In this classification we can divide cost into two groups, internal and external costs.

1.1 Internal costs are the costs that incurred by the organization or the institute in providing health care service

1.2 External costs are those costs undertaken by the outsider of the health care provider, such as the time costs and travel costs of the patient, their relatives and the community as a whole.

Classification of cost by this way is very important in health care planning and policy making because it is necessary to take these two groups into consideration for resources allocation with efficiency and equity concerns.

2. Classified by "activities":

Internal and external to the organization can be divided into two groups by the activities.

2.1 Direct costs are the group of cost categories which are spent directly on the activities.

2.2 Indirect costs are those costs which are not spent directly to the activities. The concept of indirect costs can refer to the economic value of any consequence that cannot be counted as a direct costs.

### 3. Classified by "expenditure":

The costs categories which occurred internal and external or direct and indirect to the activities can be divided into two groups.

3.1 Explicit cost (Tangible cost) is the actual costs that given up in an activity and can be measured in term of money.

3.2 Implicit cost (Intangible cost) normally are not measured in term of money because they are not the result of market transactions. This is because costs are thought of in terms of utility, which is the basic measure of economic well-being. Rational people might prefer to avoid grief, anxiety, frustration and pain. Therefore these items are known as intangible costs.

In the context of health care, "Intangible cost" are particularly relevant as they enter into the assessment of many health care alternatives. The importance of the intangible costs may vary according to type of illness or treatment, and according to the importance attached to the viewpoint of the patient and his or her family. From the viewpoint of the health service, for example, delay and anxiety may affect the patient and even his employer, but they do not affect the costs of the hospital.

4. Apart from the classification we have mentioned, sometimes cost can be classified in terms of medical and nonmedical costs.

4.1 Medical costs are those costs which involve in the medical treatment and medical care, such as hospitalization, drugs, physician fees, laboratory tests, X-ray procedures etc.

4.2 Nonmedical costs are the costs that not incurred directly to the medical treatment and medical treatment, such as the administration, food, transportation, clothing, etc.

### 5. Sub - classified by inputs:

Cost classification by inputs is widely applicable and easy to follow. In any of the above classifications, cost could be further classified into capital costs and recurrent costs, which group inputs into categories in which the elements are recognizable as they have similar characteristics.

#### 5.1 Capital costs

Capital costs are the costs to purchase the major capital assets required by the program, generally equipment, building and land. There are several methods of measuring and valuing capital costs in an economic evaluation.

Characteristic of cost

Capital costs categories:

- Vehicles: Ambulance

- Equipment: Heart lung machine. anesthesia machine. cardiac monitor. surgical instruments etc.
- Buildings space: Operating room, intensive care unit, ward
- Training: Long term training activities for health personnel that occur only once per year or rarely

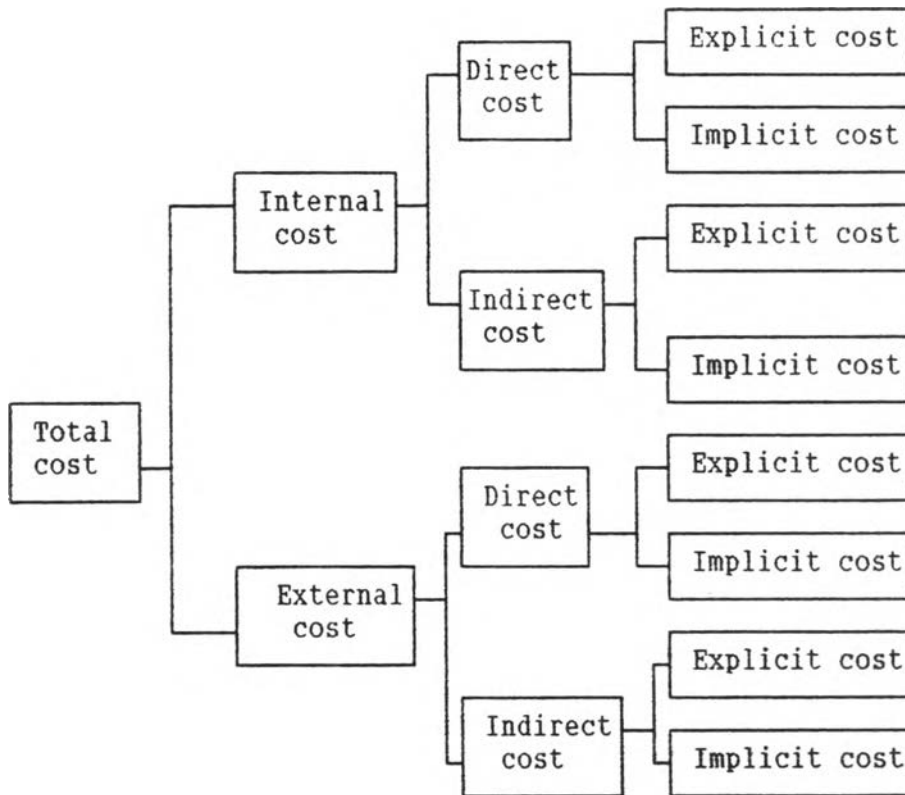
## 5.2 Recurrent costs

Recurrent costs are the costs that are incurred within one year. These include items such as:

- Personnel: Physician, nurse, technician, administrators, social worker etc.
- Supplies, drugs
- Operation & Maintenance of vehicle: Petro, diesel, tires, spare parts, insurance
- Building operation & Maintenance: Electricity, water, heating, cleaning, telephone
- Other operating costs

From the explanation mentioned above, it is observed that the distinction between capital and recurrent costs is based on the expected life of the item. Items which are used up during the course of the year, such as salaries, drugs and supplies, fall into the category of recurrent costs. Items which are expected to last for more than one year, for example, building, equipment and vehicle are generally viewed as capital costs.

Figure 2.1 Classification of costs



### Costing Concerns

When embarking a cost study in the health field, the basic questions that an evaluator might have are the following.

1. Which costs should be considered?

It is essential to specify the viewpoint, since an item may be a cost from one point of view, but not a cost from another. For example, patient's travel costs are a cost from the patient's point of view and from the point of view of the society, but not a cost from the hospital or provider point of view.

Possible points of view include:

- Society
- Ministry of health
- Other ministries
- Government
- Patients
- Employer
- Agency providing the program
- Etc.

## 2. How should costs be estimated?

Once the relevant range of costs has been identified, the individual items must be measured and valued. Although the theoretical proper price for a resource is its opportunity cost, the pragmatic approach to costing is to take existing market prices unless there is some particular reason to do otherwise.

Although the costing of most resource items is relatively unambiguous, but there are some nonmarket resource inputs to health care program, such as volunteer time, patient/family time. We should know how to impute these nonmarket resource inputs. One approach is to value by using the market price.

## 3. How should capital outlays be handled?

Capital costs are the costs to purchase the major capital assets required by the programme, they represent investments at a single point of time, such as building, equipment and land. There are two components of capital cost. One is the opportunity cost of the fund tied up in the capital asset. The second component of the capital cost is the depreciation over time of the asset itself. There are several methods of measuring and valuing capital costs in an economic evaluation. The measurement and valuation of capital costs was described in the later sections.

## 4. How should overhead costs be handled?

The term overhead cost is an accounting term for those resources that serve many different departments and programs. The costs should be allocated to different activities by apportionment. The main point to note at the outset is that there is no unambiguously right way to apportion such costs.

If a more detailed consideration of costs is required, various methods for allocation overhead costs are available as following.

a). Direct allocation: Each overhead cost is allocated directly to final cost centers.

b). Step down allocation: The overhead departments are allocated in a stepwise fashion to all of the other overhead departments and to the final cost centers.

c). Step down with iteration: the overhead departments are allocated in a stepwise fashion to all of the other overhead departments and to the final cost centers. The procedure is repeated a number of times to eliminate residual unallocated amounts.

d). Simultaneous allocation: This method use the same data as b) and c) but it solves a set of linear equations to give the allocations. It gives the same answer as method c) but involves less work.

## Theoretical Basis for Estimating Cost

### 1. Opportunity cost

The opportunity cost of an activity is the value of the alternative endeavors that might have been undertaken with the same resources. Economists make the valuation of opportunity cost based upon certain assumption. In a completely competitive market, the price of any product will equal its opportunity costs (Luce and Elixhauser, 1990).

### 2. Depreciation

The term depreciation is employed in the periodic write-off of the cost of all items of property, plant and equipment except such tangible assets as land and natural resources. The term depreciation denotes the periodic cost allocation against revenue of such tangible assets as buildings, machinery, and equipment. These fixed assets have a limited useful life: physically, they deteriorate from use and from the action of the elements. An adequate repair and maintenance policy may slow, but cannot halt. this deterioration.

Equitable methods must be used to write off the cost of fixed assets like buildings, machinery and equipment items as their useful lives decrease. Each fiscal period should be systematically charged with its proportionate share of the cost of fixed assets so that such cost will be fairly allocated as expense to each fiscal period throughout the estimated useful lives of the assets(Rossell and Frasure,1964).

### 3. Discounting

Discounting is appropriate to perform when costs are to be incurred in the future. The principle behind discounting is the positive value of time preference, that is current dollars have greater value than future dollars. Basically, dollars available now can be invested to yield higher future returns. The process of discounting involves deflating future dollars by an appropriate factor. Mathematically, it can be thought of as the reverse of computing a return on investment. To perform discounting, it is necessary to weight future dollars by the discount rate in order to reduce all future value to present values.

## Costing Procedures

Generally, there are nine steps for costing of health care service.

1. Level of costing: The level of costing may be central, regional, district or at organization level.
2. Identification of activity: This is to include all the

activities under a given programme to be evaluated. Firstly cost must be defined in terms of its functions so that relevant cost can be identified and measured.

3. Listing of cost components: List all the relevant components of cost for evaluation. Cost measurement depends upon the purpose for which the costing is desired. The crucial step in costing is to identify what are the specific components whose costs should be determined.

4. Identification of unit of measurement: This is to decide the physical unit for measuring the cost in relation to component.

5. Unit cost: Using the market price or price adjusted to "shadow price" to decide the unit cost of items.

6. Magnitude of each cost category : To quantify the volume consumed for specific activities.

7. Classification: This is to classify the cost into different categories for example, classification of cost components into donated items, imported items, cost component in relation to currency, etc .

8. Cost profile: The distribution of total cost in relation to activities and input categories.

9. Cost projection and sensitivity analysis: Using the cost data to project and analyze the costs under different scenarios.

### **Measuring and Valuing Capital Costs**

There are several method of measuring and valuing capital cost.

1. To annualize the initial capital outlay over the useful life of the asset. The method incorporates both the depreciation aspect and the opportunity cost aspect of the capital cost. The annual economic value is bases on:

A. The replacement cost of the capital item (its price in the year for which costs are measured).

B. Its expected useful life year.

C. The opportunity cost of tying up money in capital assets (are reflected by the interest or discount rate).

From the discount rate and the length of useful life year, an annualization factor is identified. The replacement price is divided by the annualization factor to give an annual cost (Table 2.2).



Table 2.2 Calculation of the annual value of capital items:

Discount rate (r)	Useful life (UL)	Annualization factor (AF) derived from r and UL)	Replacement price (RP)	Annual Cost (AC=RP /AF)
<b>Capital</b>				
Vehicles				
Equipment				
Buildings				

Source: Phillips, M. *et al* (1993)

2. Where market rates exist, these may be used to estimate capital cost, for example the rental of buildings or lease of equipment. This method also incorporates both the depreciation and the opportunity components of the cost.

3. If capital outlays relate to resources that are used by more than one program they may require allocation into "overhead" costs

### Measuring and valuing recurrent costs

Once the relevant categories of recurrent costs has been identified the individual items must be measured and valued. In the theoretical proper price for a resource is its opportunity cost. One of the approaches to costing is to take existing market prices. There are a number of methods of valuation, each of which depends on the availability of information.

#### 1. Market-base valuation

It is a type of explicit valuation of costs. The approaches in this method are, taking the actual market prices, adjusted market prices and imputed market prices. Collection of actual prices in the market is simple and straight forward.

If market imperfections exist, these prices should be adjusted to correct market prices. The decision for such adjustments however depends on:

- importance of the item
- the extent of variation from its true value
- the time and trouble of obtaining the value adjustment

#### 2. Input-based valuation

If no market price is available, it can be tried to impute

valuation. This can be based on the cost of similar items or services or substitution costs. Views of clients, policy makers and practitioners can also be considered.

**Table 2.3 Calculation of recurrent cost items**

Items	Physical unit	Unit cost	Quantity used	Cost
Personnel				
Drugs				
Supplies				
Laboratory				
Blood&IV				
etc.				

#### **Donated inputs**

For government or public hospital, there is a number of inputs which are donated by the nongovernment organization (NGO), as well as in Chulalongkorn Hospital. In this case, even the donated items have no direct cost to the hospital, it is important to include them in the cost estimation so that the full value of all the resources involved in implementing activities can be estimated. Donated supplies should be costed at their replacement cost as in the case of other materials.

#### **Conceptual Framework**

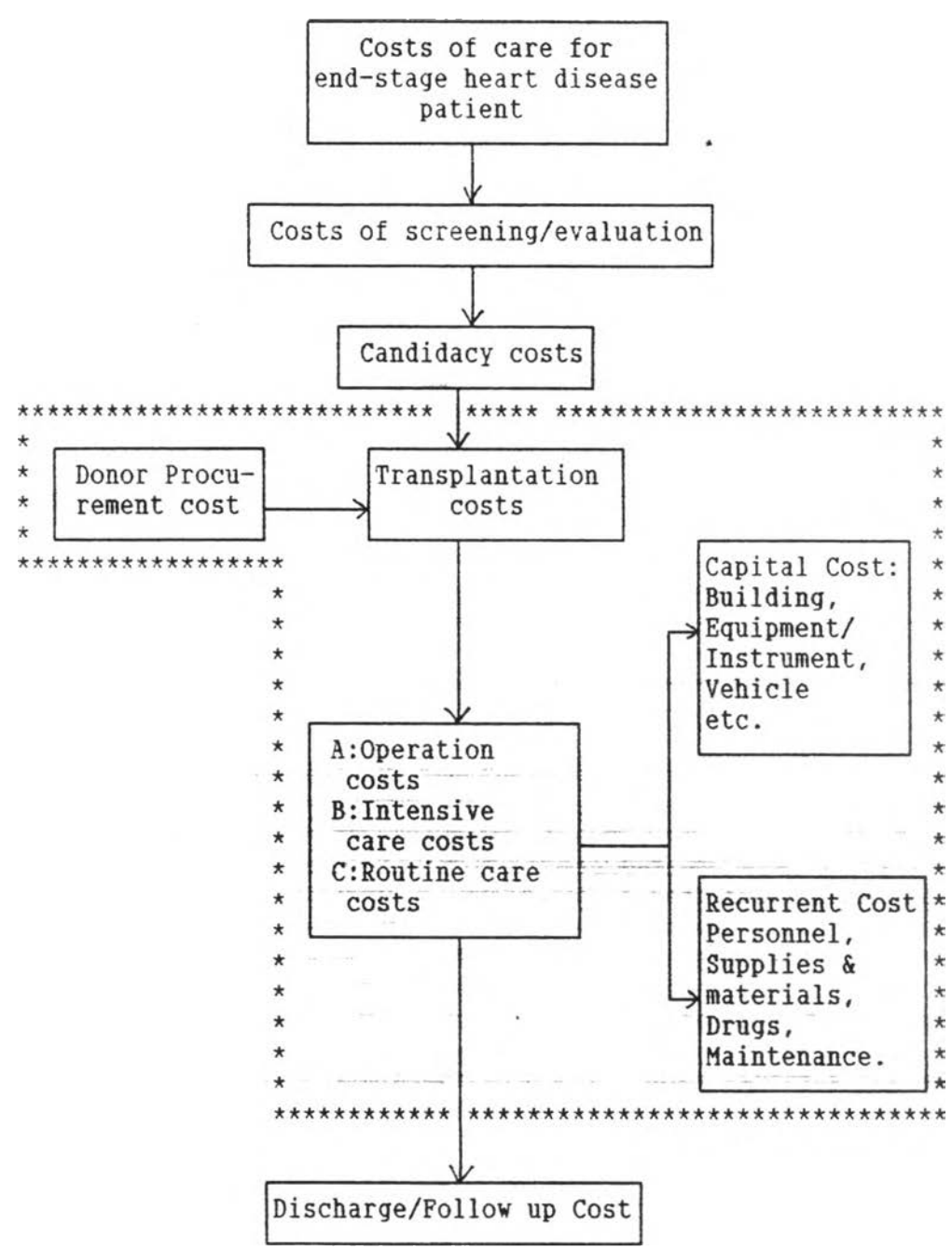
In principle total cost of a service is the sum of designated internal and external costs and the cost is direct if expenditure is for a specific activity or indirect if expenditure contributes to an activity but is not spent directly on the activity (Kaewsonthi S, et al 1983). For heart transplantation procedure the internal cost is the cost to the institute for performing the heart transplantation operation and providing the service to the patient. And the cost is direct if expenditure is spent directly on the activity.

The focus of this study is to examine the cost incurred by the hospital which provide the special service and special activities of heart transplantation to the patients with end-stage heart disease. Any others external costs are not included in this study and only the transplant costs from the day of surgery to the day of discharge will be calculated.

The conceptual framework designed for the present analysis is based on the economic principles of costing, which examines the costs

of various resources consumed. The purpose of this conceptual framework is to identify, measure and value the costs from provider perspective to facilitate the hospital administrators and health care planners with information for health care planning and management. They are basically analytical tools intended to promote efficient service and effective resource allocation. In general these analyses rest on the basic economic concepts of true costs (accounting costs and opportunity costs) of an activity which is the value of the alternative endeavors that might have been undertaken with the same resources.

Figure 2.2. Costing framework for heart transplantation procedure:



This study will focus on the costs of the highlighted areas, that is, the operation costs for heart transplantation, intensive care costs and routine care costs. To the cost of donor procurement, only the costs that incurred by the operation will be included.

## Literature Review

### 1. Heart transplantation procedure:

First observation on cardiac transplantation were made in animal models in the early 20th century. By the late 1960 cardiac transplantation in humans had become feasible. Since the first successful transplantation of a human heart in 1967, the management of rejection and infection has steadily progressed, and the long term outcome after cardiac transplantation has improve dramatically. The success of cardiac transplantation has led to an expansion of the potential recipient pool to include children and adults (Rodeheffer, 1992). Today heart transplantation is an established treatment for terminal cardiac disease. Accurate donor evaluation and treatment is essential for fast recovery after operation.

The technique of heart transplantation involves excision of the diseased heart leaving behind cuffs of the right and the left atria, pulmonary and aorta, which are subsequently attached to their counterparts in the procured donor heart. Sometimes donor and recipient operation are carried out in two different hospitals, careful coordination and timing of the donor and recipient operations is fundamental to keep the ischemic time (ie, the time take to remove the donor heart, transport to the transplant center and implant in the recipient) to a minimum. Ischemic time longer than 4 hours carries a significantly higher operative mortality. Preservation of the donor heart during the period of ischemia is achieved using a potassium based cardioplegia solution which arrests the heart in diastole, and is supplemented with tropical cooling to keep the myocardial temperature at 4 degree celsius. High pulmonary vascular resistance can occur postoperatively failure of the donor heart. In addition to the use of immunosuppressive agents to prevent rejection of the donor heart (Hakim and Gill, 1993). The growing of pre and post transplant patients and the complexity of their care underscore the need for a multispecialty approach to patient management (Khan, 1994). Heart transplantation requires a teams of various staff members, and may include one or two circulating nurses, two scrub technologists or nurses, one perfusionist, one surgeon's assistant, two surgeons and one anesthesiologist (Sala, 1993).

### 2. Recipient selection:

The acceptable candidates must have terminal cardiac disease for which there is no alternative medical or surgical therapy. The most common category of disease that results in the need for cardiac transplantation is coronary artery disease, idiopathic cardiomyopathy. A very important criteria for selection is the assessment of the patient's psychosocial status. A strong supportive social situation is important because good medical compliance and motivation for rehabilitation are necessary following transplantation. The management program following transplantation is complicated and continuous with the need for immunosuppressive throughout the remainder of the patient's life.

### **3. Donor procurement:**

The donor for cardiac transplantation procedure is the patient who has suffered irreversible brain death. Brain death is usually certified by two physicians on the basis of absent neurologic reflexes, no spontaneous respiration and isoelectric electro-encephalogram. After determination of brain death, complete informed consent must be obtained from the next-of-kin. When this has been obtained, either the donor is moved to the operating room or a team of surgeon is sent for distant procurement of the heart at the referring hospital. After brain death is established, appropriate studies of tissue compatibility are completed. The donor and recipient must be ABO compatible.

### **4. Patient management:**

Cyclosporine is given orally 4 to 5 hours prior to surgery. Postoperatively, cyclosporine is administered intravenously as a continuous infusion until the patient is able to take fluids orally. Cyclosporine serum trough levels are measured and the level is maintained between 200-400 mg per ml by adjustments of the daily dosage. Care following transplantation is similar to care for conventional cardiac patients. Patients require constant monitoring for infections and appropriate treatment when necessary (Frazier OH and Cooley DA, 1986).

### **5. Management of rejection:**

Right heart catheterization and right endocardial biopsies are performed weekly during the first 4 weeks following transplantation and frequently during period of rejection.

Infections are common in the immunosuppressed host. A high percentage of the patients treated for rejection subsequently developed infection, indicating the close relationship between infection and rejection (Frazier OH and Cooley DA, 1986).

### **6. Cost of heart transplantation:**

There are quite a lot of literature available about the cost and benefit of heart transplantation in the western countries where most of the operations were undertaken. Regarding the cost studies undertaken, estimations of the costs vary widely from time to time and from country to country, and the specific components that constitute these costs are poorly defined. For example, in the USA in 1987, it is reported that the fully allocative average cost of heart transplantation is roughly US\$150,000 (Roger, 1987).

In 1986, Goodwin compared cost of heart transplantation between USA and UK. In 1984 it was \$67,000 in the United States and 15,000 pounds in the United Kingdom. The variations due to time and place of operation necessitate the studies of cost of different countries in different time. Now the costs in the UK have been reduced further to 11,000 pounds to 12,000 pounds, but the cost in the USA may have increased. Thus, it seems that transplantation is at least four times

more expensive in the United States than in Britain. The reduced cost in the United Kingdom may be attributed to the use of cyclosporine and the consequent reduction in length of hospital stay and a fewer early rejection episodes (Goodwin, 1986).

Stanford cardiac transplantation center requires a \$125,000 deposit to cover the cost of surgery and the first year of follow care. This is three times what Stanford requires for coronary bypass surgery. The average first year cost of a heart transplantation at Stanford University during the period from May 1978 to April 1979 was US\$ 110,000 and US\$15,000 each year thereafter (Hellinger FJ., 1980).

In Asia the cost of transplantation in each of 9 countries which performed transplantation varied between \$20,000 - \$30,000. This cost only the operation and one month period of expense excluding the personnel salaries (Sakornpant, 1994).

In Australia, the cost of cardiac transplantation is average now between \$50,000 to \$75,000 for the first year and about \$10,000 for each subsequent year (Spratt, 1992).

In Netherlands there was also a study about cost of heart transplantation. The costs were calculated per patient related to individual treatment of patients and to the whole program, which were included costs of treatment during screening, on the waiting list, and after transplantation. Costs per patient were calculated by multiplying volumes and prices. All costs which could be specified per patient with respect to volume and unit costs were excluded from the average costs per in bed day and out-patient visit and were analysed separately. Costs per diem were calculated as far as information permitted. The methodology to calculate unit costs consisted of combining different quantities such as data about the total annual costs of the various departments, the relative weights attached to the different procedures carried out in a department. Costs during the screening were subdivided according to the decision reached after screening or to whether the patient died during screening. Costs on the waiting list were estimated at NLG 5,000 per patient. Costs after transplantation include the costs of the transplant operation which were estimated at NLG 19,014 (Hout, 1993).

Saywell RM, et al studied a cost analysis of heart transplantation from the day of operation to the day of discharge. Hospital costs were examined in a consecutive series of 53 patients who underwent heart transplantation between October 1982 and February 1987. An accounting cost methodology was used to convert billable charges to costs for 29 separate hospital cost centers. The result report in this study indicated that total costs for the transplantation ranged from \$22,066 to \$137,100 with an average adjusted total cost of \$35,593 (Saywell RM, et al. 1989).

Although heart transplantation procedures are considered as life saving, the problem is their cost. There are some studies available in the Western countries about the cost and benefits of

transplantation. For example, Evans' analysis compared the cost and outcome of heart transplantation with those conventional care for congestive heart failure yielding a figure of \$23,000 per added year of life (Evans et al.1984).

Heart transplantation is generally viewed as a costly technology with obvious benefits, although there is not a consensus as to whether the benefits are sufficient given the cost of the procedure. This has led to a considerable disagreement as to whether heart transplantation is an experimental or a therapeutic procedure (Blendon,1986).

Payers are mainly concerned that transplant costs will increase as a function of increased donor organ availability, which means already scarce health care resources will be maldistributed to take care of the needs of the small portion of the sick people (Kastiel.1985). Skeptics argue that resources allocated to heart transplantation would be better spent on preventive health care initiatives (Eddy,1986). There are the kinds of questions that arise in a health care system that is driven by an ever-expanding technology base and a seemingly insatiable consumer and provider demand to use medical care, yet faces a future of limited resources (Iglehart,1983).

Much attention continues to focus on the cost-effectiveness of transplantation relative to other medical and surgical procedure. Recently, several surveys suggest that public support for heart transplantation is waned. Unfortunately, undue attention and focused on the transplantation cost, with little consideration of the benefits of patients derive. The cost of transplantation,not only to the patient but also in terms of its impact on the national expenditure for health related activities, must be considered as well (Herrell,1980).