CHAPTER 3

RESEARCH METHOD

Scope of Study

In this study, only the internal costs that incurred to the institute directly to provide the service of heart transplantation were included. so the provider direct costs for transplant procedure from the day of operation to the day of discharge are focus . which are those costs that are accumulated from the time of surgery to the patient's initial discharge will be determined. Those will cover the costs in three area where the patient stays, i.e., operating room, intensive care unit (ICU) and surgical ward. Therefore the scope are described as follow.

1. The study will cover only the provider direct costs which are those costs incurred by the hospital during the period of transplantation.

2. The study will focus on the cost from the day of operation to the day of discharge.

Key Words Definitions

1. Cost: Cost is referred to the economic cost, including all the resources input for the specific activities of heart transplantation.

2. The patient with end-stage heart diseases: The subject of heart disease is quite broad encompassing a multitude of pathophysiological processes for which medical therapy is only palliative. The patient with end-stage heart disease typically has "forward failure" demonstrated by signs and symptoms of diminished cardiac output, as well as "backward failure", exhibited by pulmonary and hepatic congestion. The clinical presentation varies from case to case . Some patients may be limited in their daily activities but are capable of maintaining sedentary jobs, whereas others are moribund, requiring intravenous inotropic support or mechanical cardiac assistance. Many patients find that sleep patterns and eating habits disrupted. Routine activities become laborious or even impossible, as insidious deterioration progresses (Futterman LG, 1988).

3. Heart transplantation: Heart transplantation is an operation which performed to the patient with totally incapacitating myopathic disease, which may be secondary to widespread coronary-artery disease or to idiopathic or rheumatic cardiomyopathy. Patients with uncorrectable congenital abnormalities or those who can not be weaned from mechanical circulatory support may also survive after heart transplantation. (Russell PS, et al 1979)

Research Design

It is the cross-sectional study design. Data were collected retrospectively from the medical record of the patients transplanted during 1987 to 1994.

Population

1. Target population and population to be sampled:
Patients undergone heart transplantation at Chulalongkorn Hospital during 1987 to 1994.

2. Inclusion criteria: The patients who had heart transplantation and survived until the initial discharge.

3. Exclusion criteria: The patients died during the operation and before discharge.

4. Sample size:

We intended to included all cases of heart transplantation patients who met the inclusion criteria of the study. But only the 12 medical record of the patients are available.

Data Compilation

The cost categories was retrieved from each patient's medical record about treatment, laboratory test, medical and nursing services. Some data are collected from the record of the unit which provide the service to the patients including operating room, intensive care unit, and surgical ward. The costs of drugs, medical supplies and equipments were taken from pharmacy department and purchasing department. For the diagnostic laboratory test, the unit cost was taken from the available study of " Unit cost of the laboratory tests and diagnostic imagine at outpatient department in Chulalongkorn Hospital " by Pintusorn Hempisut in 1992. The cost was adjusted to the base fiscal year 1994.

Costing Assumptions

1. A system that calculate costs is based on the uses of resources.

2. The distributions of expenditure on personnel, equipment and other resources among patients fall into these categories.

a) Individual patient cost: cost of items clearly identified with the patient consumable such as drugs and infusion.

b) Resource-area cost: these derive from the patients' use of medical, paramedical and nursing care in the investigation and

treatment. Each resource-area cost included the appropriate proportion of overhead.

3. A patient's use of resources is defined in terms of unit of use and unit of items.

Costing Methods

One of the difficulties in examining the cost of heart transplantation is that the direct economic costs of transplantation include many separate phases of diagnosis and treatment such as preoperative costs, operative costs, postoperative costs and organ procurement costs.

This study is limited to an examination of the hospital costs from the day of transplantation to the day of discharge. The costs before operation and after discharge were not included as their compilation was beyond the stage of this study. Finally, the study does not address the indirect or long term social costs of heart transplantation.

To calculate the average hospital cost for each patient, the costs to the hospital of individual services actually received by each patient was identified, permitting each patient to bear a share of both the direct service costs and over head costs on the basis of the level of services the patient received.

The total hospital cost was broken down into 5 cost categories which are the capital cost and recurrent cost.

a) Direct expenditures for personnel and fringe benefit.
b) Direct expenditures for drugs
c) Direct expenditures for supplies
d) Direct expenditure for diagnostic laboratory test and other special treatment
e) Allocated expenditure that is the overhead costs of the equipment, and facilities of each area that the patient have been involved.

Cost figures are derived from each function by cumulating the money value of all resources, including the worker time, utilized in performing the various activities within the heart transplantation procedure.

1. Identification of activities for heart transplantation procedure.
There are 4 main activities to be identified the input resources.

1.1 Donor acquisition either in Chulalongkorn Hospital or other hospitals.

1.2 Operation taken in both donor and recipient.

1.3 Intensive care during immediate postoperative period.

1.4 Routine care for cardiac patient in surgical ward until discharge.

2. Identification of input resources.

Identification of resource input is an important step in the cost estimation process. For heart transplantation, the following direct medical items should be considered.

2.1 Physician services

2.2 Nursing care service

2.3 Overhead allocated of capital costs.

-Building
-Device or equipment (depreciation over life of equipment)

2.4 Diagnosis test

-Routine laboratory test
-Special laboratory test
-Radiology

2.5 Treatment services

-Operating room and anesthesia service
-Intensive care unit
-Routine care service
-Acquisition of organ transplant
-consumable supplies
-Treatment of complication
-Blood products
-Oxygen and gas mixture
-Drugs

The following Table 3.1 gives a detailed lists of capital costs for heart transplantation procedure. And Table 3.2 lists the direct recurrent cost items for the operation.

Table 3.1. Identification of capital cost items for heart transplantation

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Category	Items

OR

Equipment:

Surgical light
Head light
Heart lung machine
Electrocautery
Cardiac monitor & defribillator
Hemotherm
Anesthesia machine
Heart lung instruments set
Basic special major instruments set
Electric power sternum saw
Finochietto

ICU

Intraaortic balloon pump
Radiant warmer
Positive pressure ventilator
Pressure monitor
Pulse oximeter
Infusion pump
Suction vacuum
Cardiac monitor & defribillator
Low pressure suction
Temporary pace maker

Surgical ward

Bird's ventilator
Infusion pump
Suction vacuum
Defribillator

Building:

Operating room utilization space
ICU utilization space
Surgical ward utilization space

Vehicle:

Ambulance for transportation of donor heart from other hospital

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Table 3.2 Identification of recurrent cost items for heart
         transplantation

Category	Items
Personnel	A team of cardiothoracic surgeon A team of anesthetist A team of perfusionist OR Nurses ICU Nurses WARD Nurses Nurse aid & PN (practical nurse) Porters
Blood&Fluid infusion	0.9% NSS 5%D/NSS 5%D/N/2 5%D/W Acetar Whole blood FFP (Fresh frozen plasma) PRC (Packed red cell)
Drugs	Antibiotic Azathioprine Cyclosporine Calcium gluconate Isoproterenol Methylprednisolone Methylprednisolone sodium succinate Nystatin Phenobarbital etc.
Medical supplies	Disposable items & material etc.
Laboratory test	Blood cyclosporine level Blood sugar,blood gas, blood group CBC, BUN Cr, Electrolyte Hematocrit Hemoculture etc.
Diagnostic radiology	Chest X-ray Heart scan Echocardiogram Cardiac catheterization Endomyocardial biopsy EKG (Electrocardiogram) etc.
Gas mixture	Oxygen, nitrous oxide

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3. Determination of measure unit.

Identification of the unit of measure of each item is important to allocate or distribute the resources across several categories. The unit of measurements are broadly classified into time scale, volume, weight, distance, space and number.

Table 3.3 Measure unit of the cost items

Category	Items	Unit of measure
Recurrent costs		
Personnel costs	Salary	Time worked (day or hour) for patient
	per diem	Time worked (day or hour)
Supplies & Drugs	Consumable	Volume used (liter, etc) Weight consumed (mg, etc) Units of used (tablets, etc)
Blood & fluid infusion	Consumable	Units of used
Laboratory tests	Type of the tests	Number of the tests
Dx radiology	Type of diagnostic	Number of Dx radiology
Gas mixture	O_2, N_2O	Volumn of used (liter)
Operation & maintenance	Buildings Equipments	Space utilized (sq.m)
Capital costs		
Vehicle	Rental	Distance travelled (Km)
	Running	Distance travelled (Km)
Buildings	OR	Space utilized (sq.m)
	ICU	Space utilized (sq.m)
	Surgical ward	Space utilized (sq.m)
Equipments	OR equipment& Instruments	Time used (approtion)
	ICU equipment	Time used (apportion)
	Ward equipment	Time used (apportion)

4. Estimation of unit cost of items

Unit cost or price of items means the price of items expressed as physical or natural units. Market values could be collected for most of the input items.

Capital costs:

Capital items are the ones that last longer than one year. Capital costs are expressed as annual costs and to estimate this. annualization factors was used. The steps in estimating the costs on capital items are:

- identification of the capital items
- collection of current (replacement) value
- determination of the expected useful or working lives of each capital items (Reference used in this study "Estimated Useful Lives of Depreciable Hospital Assets, 1988. The American Hospital Association
- estimation of the annual cost by using annualization factor

Annualization factor can be obtained from the annualization table (Creese & Parker, 1993).

If a given capital item is shared for different activities, appropriate disaggregation of this cost should be followed based on allocation criteria.

5. Cost allocation criteria.

5.1. For equipment & instruments:

Adjusted yearly cost = Current value of equipment / annualisation factor

Cost per hour = Adjusted yearly cost / yearly hour used

Cost per patient = Total hour used * cost/hour

5.2. For building: (Including OR, ICU and WARD)

Estimate the utilization area of each facility in unit of square meter and calculate the unit cost by using the commercial rental rate of building space in the same location per square meter as a unit cost per day.

Cost for building = Space used * utilization time * unit cost

5.3. For vehicle:

For the vehicles, the actual cost of the vehicle plus the approved highest maintenance cost (normally one third of the cost of the vehicle) will be used to determine the investment cost on vehicle. However. for calculating the vehicle costs of one single activity like heart transplantation, it would be more convenient and reasonable to use the market price for renting the same type of vehicle.

Using the rental rate of the private hospital as the unit cost per Km for ambulance.

5.4. For personnel:

Salary plus fringe benefits and per diem has to be considered for calculating the per day cost for the personnel.

In this study we used the mean of the salary of the personnel who give the direct service to the patients (physician, nurse. anesthetist, perfusion, nurse aid, porter) in each area as a proxy of the salary of personnel.

Unit cost = (Salary + Benefit + Per diem) / working hour

Cost of personnel = Time spent for patient * unit cost

A distribution of personnel cost was obtained from the ratio of personnel to patients and estimate the medical and nursing care times consumed by the patient.

For example: In Intensive Care Unit the general planned nursing care ratio is 1:1 for the day shift (8 hours) and 1:2 for the night shift. This means that one nurse is assigned to no more than one patient in the day shift or two patients in the night shift.

In surgical ward the nursing care ratio is 1:4 for the day shift and 1:9 for the night shift.

For physician it is quite difficult to distribute the cost for the medical care in surgical ward but in ICU at least one physician should spent 24 hours to the heart transplanted patient. In this case we would assume that the time that physician spent to the patient is the same ratio as the nurse in the surgical ward.

5.5. Supplies & Materials:

For supplies, a 5 to 10% wastage needs to be added to market value of the items to calculate unit cost. This should also include transportation charges. Donated or subsidized items should be incorporated using their market value.

Costs of medical supplies for transplanted patients based on individual consumption. which are cost of items clearly identified with the patients. such as drugs, supplies and infusion.

5.6. Maintenance cost:

Estimate the water, electricity, air-conditioning and cleaning costs by the time of utilization. Estimation of annual maintenance requirements for buildings is often expressed as a percentage of the total capital cost (2-3% per year) (Hanson and Gilson,1993).

6.Valuation every inputs into money terms

By identify the unit cost of each input and calculate the total cost.

Valuation of costs:

The sources and methods of valuation of costs need to be clearly stated. Costs are normally valued in units of local currency based on prevailing prices of items. All current and future program costs are normally valued in constant dollars of some base year (normally present year) in order to remove the effects of inflation from the analysis. "Cost" is the value of resources used. The objective of valuing costs is to obtain an estimate of the worth of resources depleted by the program.

7.Calculation of cost incurred.

If the data on the unit cost and number of units are available, simple multiplication of these variables will give the actual cost of each input category. For composite cost measures such as personnel, transport, equipment and area service, allocation percentage has to be used to disaggregate the cost.

Cost models for heart transplantation

In assessing the cost of heart transplantation procedure, it is generally useful to think of the distinct cost components as follows:

1) pretransplant cost,
2) evaluation and screening cost,
3) transplant cost, and
4) post transplant cost.

Pretransplant costs are those incurred in caring for an end-stage cardiac patient before transplant. Evaluation and screening costs are those associated with "working up " a patient to determine if he is a suitable transplant candidate. In general sense. all of the costs described thus far are pretransplant costs. Transplant costs are those

costs that are enumerated from the time of surgery until the patient's initial discharge. Finally, postoperative costs are those incurred after initial discharge following the transplant.

1. Model for costing heart transplantation program

Total cost of the program = $CPT_\chi + C_S + CT_\chi + CPOT_\chi$

CPT_χ = Pretransplantation Costs

C_S = Screening Costs

CT_χ = Transplantation costs

$CPOT_\chi$ = Post transplantation Costs

Pretransplant cost is the cost of caring the end stage of heart disease patient which include inpatient and outpatient curative service

Pretransplant costs = $C_{IP} + C_{OP}$

C_{IP} = Inpatient curative service cost

C_{OP} = Outpatient curative service cost

Screening cost is the cost of evaluation process which include a number of diagnostic procedures and examinations. The comprehensive transplantation evaluation can be done on an outpatient or inpatient basis. Components of the evaluation protocol may vary among patients but generally include measurement of these following items:

1) Physical examination
2) Laboratory studies
-Biochemical: electrolyte,LFT,triglycerides, cholesterol, arterial blood gas analysis and urine analysis
   -Hematologic: CBC, platelet count, PT and PTT
   -Immunologic: ABO type and antibody screen
   -Radiologic studies: PA and lateral chest x-ray
3) Pulmonary function testing
4) Cardiac catheterization
5) Echocardiogram

Screening cost = $C_{IP} + C_{OP} + D_\chi + E_\chi$

C_{IP} = Inpatient curative service cost
C_{OP} = Outpatient curative service cost

CD_χ = Diagnostic procedure cost

CE_χ = Examination cost

Transplantation cost is the cost incurred by the provider from the day of surgery to the day of discharge. Those costs are include donor acquisition cost, operation cost, intensive care cost, and routine care cost.

Transplantation costs = $C_{DON} + C_{ICU} + C_{OR} + C_{WA}$

C_{DON} = Donor acquisition cost

C_{ICU} = Intensive care cost

C_{OR} = Operating room cost

C_{WA} = Ward routine care service cost

Post transplantation cost is the cost incurred after the patient initial discharge or it is a follow up cost which can be also on the basis of inpatient or outpatient curative service. These are include the drug cost and the diagnostic testing for rejection which are the major cost.

Post transplantation cost = $C_{IP} + C_{OP}$

C_{IP} = Inpatient curative service cost

C_{OP} = Outpatient curative service cost

In this instance, both in- and outpatient measuree of curative service were included in the heart transplantation process, as well as measure of the medical-surgical treatment, diagnostic radiology and laboratory tests are also included. Each of these activities consume the health service resource that can be measured in capital and recurrent cost. Then total provider cost can be calculated as following.

2. Model for calculating the total provider cost

Total provider cost = Capital cost + Recurrent cost

C_{CAP} = $C_{BLDG} + C_{EQUIP} + C_{VEH}$

C_{CAP} = Capital cost

C_{BLDG} = Cost of Building

C_{EQUIP} = Cost of Equipment
C_{VEH} = Cost of Vehicle

C_{REC} = $C_{PER} + C_{MED} + C_{LAB} + CD_X + C_{CON}$

C_{REC} = Recurrent cost

C_{PER} = Cost of Personnel

C_{MED} = Cost of Medication and Supplies

C_{LAB} = Cost of Laboratory test

CD_X = Cost of Diagnostic radiology test

C_{CON} = Cost of other consumable items

3. Model for calculating the personnel cost

$$PC_{ij} = \sum_{i=1}^{n} \{ \sum_{j=1}^{n} (Dr_{ij}*u) + (Nu_{ij}*u) + (At_{ij}*u) + (Pe_{ij}*u)$$

$$+ (Ot_{ij}*u)\}$$

Where:
PC = Personnel cost
Dr = Physician
Nu = Nurse
At = Anesthetist
Pe = Perfusionist
Ot = Other staff
u = unit cost
i = Working time units contributed to the patient
j = Personnel of different departments

4. Model for calculating the equipment cost

$$EC_{ij} = \sum_{i=1}^{n} \{ \sum_{j=1}^{n} (OR_{ij}*u) + (ICU_{ij}*u) + (WD_{ij}*u)\}$$

Where:
EC = Equipment cost
OR = Operating room equipment
ICU = Intensive care unit equipment
WD = Surgical ward equipment
i   = Items of equipment
j   = Proportions of unit allocated to the patient
u   = unit cost

5. Model for calculating the medication and supplies costs

$$MC_{ij} = \sum_{i=1}^{n} \{ \sum_{j=1}^{n} (Dg_{ij}*u) + (MS_{ij}*u) \}$$

Where:
  MC = Medication cost
  Dg = Drugs
  MS = Materails and supplies
  i = Item of drugs, materials and supplies
  j = Quantity used for the patient
  u = unit cost

6. Model for calculating the laboratory and diagnostic Radiology cost

$$LC_{ij} = \sum_{i=1}^{n} \{ \sum_{j=1}^{n} (Lb_{ij}*u) + (Re_{ij}*u) \}$$

Where:
  LC = Laboratory and radiology examination costs
  Lb = laboratory examinations
  Re = Radiology examination
  i = Item of' laboratory or radiology examinations
  j = units used for the patient
  u = unit cost

7. Model for calculating the building cost

$$BuC_i = \sum_{i=1}^{n} (OR_i*u) + (ICU_i*u) + (WD_i*u)$$

Where:
  BuC = Building costs
  OR = Operating room space
  ICU = Intensive care unit space
  WD = Surgical ward space
  i   = Space used by the patient
  u   = unit cost

Data analysis

     1. This study is intended to examine only the provider internal direct cost of heart transplantation from the day of surgery to the day of discharge.

     The cost analysis will be the average cost of a patient performed heart transplantation.

$$AC = \frac{TC}{n}$$

(Average cost = Total cost divided by number of patient)

     2. The components of costs will be analyzed by classification of input, that are capital and recurrent inputs. Cost by area of activity in three area, including operating room, intensive care unit and surgical ward where the patients stay will be also explored in this study. So we can see the difference of the costs among those area.

     3. The average and percentages of the cost components will be calculated and compared among each category.

     4. Regression analysis was used to find the relationship between the total cost and the variable of cost components include length of stay in the hospital.

     5. Sensitivity analysis was undertaken to evaluate the effect of length of stay on the total cost.