



Original Research Article

Study on Cost-Benefit Analysis of Computerised Tomography (CT) Scan

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Received: 12/06/2014

Revised: 05/07/2014

Accepted: 07/07/2014

ABSTRACT

Conventional X-ray equipment became commercially available in 1896. Computerised Tomography became available in 1970s. Since, its advent the diagnostic imaging has metamorphosed into one dynamic modality of investigations. The clinicians started depending on imaging more now than ever. Health care (or healthcare) is the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments in humans. Health care systems are organizations established to meet the health needs of target populations. Cost-benefit analysis is often used by governments and other organizations, such as private sector businesses, to evaluate the desirability of a given policy. It is an analysis of the expected balance of benefits and costs, including an account of foregone alternatives and the status quo.

Cost-benefit analysis (CBA) is a systematic process for calculating and comparing benefits and costs of a project. Main purpose of CBA is to determine if it is a sound investment/decision (justification/feasibility). In CBA, benefits and costs are expressed in monetary terms. In this study, CBA tool was applied in CT scan facility in a hospital. The benefits, in the terms of profits, to the management or ownership of the hospital were studied. The profits if continued over a period of 4-5 years would enable break-even to the investors.

Key words: Computerised Tomography Scan, Imageology costing, Cost-benefit analysis.

INTRODUCTION

Computed Tomographic scanners are one class of diagnostic imaging instrument - devices used by physicians and other health care workers to obtain information about physiological structures within the body. Several other methods of producing images preceded CT scanners, including conventional X-ray, electro-diagnostic, nuclear medical and ultrasonic imaging equipment. Numerous other methods have emerged since the introduction of CT. ^[1]

The medical equipment market has several distinct segments. These segments include research hospitals, community hospitals and private physicians' offices. CT followed the typical medical equipment adoption path through the segments. The path is found, with local variations, in medical equipment markets throughout Western Europe, North America and Asia.

Conventional X-ray equipment became commercially available in 1896. Electro diagnostic devices, such as

electrocardiographs and electroencephalographs, were introduced during the early part of the century. Commercial prototypes of nuclear medical equipment were introduced during the early 1950s and achieved clinical acceptance in the 1960s. Similarly, ultrasonic imaging commercial prototypes became available in the mid-1950s, with clinical acceptance occurring during the late 1960s and early 1970s. Since the computed tomography commercialization of the early 1970s, nuclear magnetic resonance imaging, digital radiography and several other imaging methods have been introduced as commercial prototypes; and a few have achieved clinical acceptance.

The first CT instrument was placed in a British hospital in 1972. The scanners then spread slowly throughout Western Europe, being placed at a few research institutions in each country. By the end of 1977, about 200 CT instruments were being used in Western European countries. The majority of the placements were in Britain, France, Germany and Italy. [2]

In the Asia region, it was first in Japan, the CT diffusion occurred much more quickly than in Europe, however, after introduction of the first CT system in 1975, placements grew at a rate similar to that in the U.S. By the end of 1977, about 300 instruments were in use in Japan. [2]

It is difficult to be sure as to when and where the first X-ray machine was installed in India. The late Dr. K. P. Mody had mentioned, in his editorial in the Indian Journal of Radiology & Imaging, in 1956 that the first X-ray machine was imported by a chemist in 1902 into India; that was only 7 years after the discovery.

In today's health care environment, the equipment purchase must be cost justified. As India is a developing country with constrained resources and hi-tech hospitals, CTs are most cost effective than

other image modalities on image quality. Establishment and maintenance of CAT scan unit in a hospital is expensive and every effort must be made for optimum utilization of this equipment in appropriate manner. There is a controversy among medical practitioners and general public that unnecessary investigations are done for patient care. Because of these conflicting views many investigative procedures are evaluated to note their utilization.

In an era of cost-intensive medical care, every equipment being installed in health care institutions need to be fully & properly utilized. An optimum utilization of equipment will result in: [3]

- Optimum patient handling and rapid turnover.
- Minimum possible costs.
- Quality patient care & satisfaction.

The evolution of new technology begins with establishing its technical efficiency and diagnostic accuracy. Cost effectiveness ratios derived through cost effective analysis can be used to compare the efficiency of different health programs although such comparisons should be made cautiously because of uncertainties associated with many estimates of cost and effectiveness.

Aim: To analyze the cost-benefits to management of hospital, of a diagnostic imaging modality - Computerised Tomography (CT) Scan.

Objectives:

1. To study the staffing pattern, duty hours, workflow into department, work-days of the CT scan facility of Kasturba Hospital.
2. To compute the fixed & variable cost-heads that makes into one unit of scan.
3. To assess the Cost-benefits of the CT scan equipment to the organisation.

METHODS & METHODOLOGY

Prospective Study: Keeping in view the aims and objectives, a prospective study was carried out in the department of Imageology with respect to CT scan facility and the workload, and cost-benefit of CT scan.

For Cost-Benefit Analysis: The revenue on CT scan facility was calculated in the method as elaborated. The billing data of charges per scan to the patients was collected over the 6-month period, on a prospective basis, which included both OP and IP cases.

The expenditure on CT scan facility was calculated in the method as elaborated below. After analyzing over the 6-month data on a prospective basis, a detailed study of costs was undertaken.

1. Capital Costs:
 - a. Installation cost of the CAT scan was taken. The depreciation @ 10% per annum was considered (Straight-line method of depreciation) as its cost.
 - b. Cost of the Auxiliary equipment.
 - c. Furniture @ 10% depreciation per annum.
2. Salaries:

Staff salaries from the department were considered. Administrative staff salaries as a percentage of total hospital management costs were considered partly in administrative cost heads. Both the above are fixed costs, not varying with number of scans. Below costs are variable costs.

3. Consumables:
 - a. Films and Film Processing Chemicals.
 - b. Contrast.
 - c. Stationery.
 - d. Electricity – Machine, AC, electrical fittings, Computers etc.
 - e. Computer discs and printers.
4. Miscellaneous expenses.
5. Overheads:

- a. Administrative Costs: Certain percentage of senior administration costs.

Limitations of the study:

The concessions given, the free cases and the cases of academic interest were noted. As it is mandatory to deduct this amount from the total revenue generated during the period of study.

The price of the CT scans does not vary according to the category of admission and it is not charged extra for emergency cases also.

RESULTS

For the purpose of knowing the Cost-benefit of CT scan facility, the calculations were basically classified into the expenditure (costs) versus the revenue (benefits) generated for a single scan over a period of 6-months. From this data the unit cost of CT scan, which is the cost incurred by a department to arrive at the Final diagnosis of the patient from a scan, was deduced. While calculating the expenditure adequate precaution was taken, and the standard protocol was followed as quoted in British Medical Journal, enunciating the cost-benefit of medical equipment. (Sapure. K. et al, Cost-benefit of MRI in the Neurosciences, British Medical Journal, and 8:1:36-39, March 1992).^[4]

Calculation Of Fixed Costs

- 1) The cost of the Wipro GE CT Prospeed SX Advantage Whole Body Premium Helical CT Scanner bought along with the accessories like Workstation is Rs. 196. 25 lacs.
- 2) Depreciation was calculated @ 10% per annum by the Straight Line Method assuming that the effective life span of equipment is 10 years.
- 3) Expense was calculated for a total period of six months and by dividing the total amount with the number of months, the monthly expense was

deduced. Then this was divided by the average number of scans done in a month during the six-month period of our study to derive the costs to the institution per single scan.

- 4) The maintenance of the equipment is a Comprehensive Maintenance Contract per annum, which covers the cost of the spare parts also, in case of repairs. This was given to the Manufacturers themselves.
- 5) For the calculation of salaries, the staff required is 6 per single shift. No additional perks are given to the Radiologist, according to the Policy of the organisation.
- 6) To calculate the Variable Costs, which varies according to the volume of activity the various consumables used in taking out individual scans was done as noted below.

Calculation Of Variable Costs

These costs were for 1993 scans done over 6-month period. The Cost of each Unit of Electricity @ Rs. 5.20/-.

Table 1: Showing Electricity Cost By Various Cost Heads Per Scan For 6 Months (All figures in Rs.):

Sl	PARTICULARS	6 MONTHS	PER SCAN
1	By the Equipment	2, 99, 520/-	150/-
2	A. C. Unit	4, 49, 280/-	226/-.
3	Computers	37, 740/-	19/-.
4	Electrical fittings	9000/-	5/-.
5	Film Processor	1872/-	1/-.
	TOTAL	7, 97,412/-	401/-

- The Machine, 80 KV, at the present workload, is run for 4 hours in a day, for an average number of 10.5 cases in a day.
- The 20 Tons of AC consume 20 Units/hour and run for a period of 24 hours in a day, 30 days in a month and 365 days in a year.
- The Computers (Workstation) in the Department consume 5 Units/hr,

considering that they are operating for 8 hours in a day.

- The tube lights, 30 in nos. @ 0.04 Units/hour per tube, considering 8 hours of illumination in a day.
- The Automatic film processors, @ 4 Units/hour, used for 30 min. in a day, for the present workload, as they require 1.5 min to process single film.
- The consumption of Inj. Ultravist (non-ionic) contrast from German Remedies Co. Ltd. during the study period, 610 vials @ 1186.04/- per vial.
- The films used in CT scan area LT2B size 14x17" of Agfa make @ 7293/- for 100 films.
- The cost of the film covers @ Rs. 7.10/- per piece. They are Velcro PVC sheeting with print of hospital name and with name card attached. They are of the 15x18" size.
- Printer and stationery are used for generating the reports and floppies and Computer discs are used to store the reports of the cases.
- Administrative Costs are the indirect costs that are gone unnoticed. This was considered as 10% of the total expenditure.

This table shows that the depreciation of the equipment and the electricity consumption are the important cost heads in the running of CT scanner, amongst the electricity cost heads.

Revenue Generated: The number of scans that were done over the six months period was 1993. The price for the scans does not vary with different categories of admissions/accommodation, but, it does vary with the quantity of contrast used, the number of films consumed per scan. All these were taken into consideration, while calculating the revenue.

Table 2: Showing Expenses Incurred For A 6-Month Period And Per Scan And The Percentage Proportions Of Various Cost Heads To The Cost Per Scan (All the figures in Rs.):

COST-HEADS	6 MONTHS	PER SCAN	%
I. CAPITAL COST:			
Cost of equipment → 196.25 lacs.			
a. Depreciation @ 10% p.a.	9, 81, 250	492.3	28.01
b. C. M. contract	4, 25, 000	213.3	12.11
c. Furniture; Depreciation @ 10% p. a.	11, 277.80	5.7	0.32
2. SALARIES			
3. CONSUMABLES:			
A. Electricity	7, 97,412/-	401	22.8
B. Films	1, 82, 325	91.5	5.2
C. Contrast	3, 61, 755.90	181.6	10.33
D. Film Processing Chemicals	24, 000	12	0.68
E. Film Covers	14, 150.30	7.1	0.4
F. Printer & Stationery	29, 690	16.4	0.93
G. Miscellaneous	5, 000	2.5	0.11
4. Administrative Overheads			
TOTAL	35, 00, 696	1756.5	99.91

Table 3: Showing Number Of Cases Done And The Revenue Generated (in Rs.) In each month:

MONTHS	CASES	AMOUNT
April	271	4, 88, 063
May	370	6, 59, 526
June	301	5, 94, 525
July	359	6, 43, 783
August	339	5, 81, 349
September	353	6, 66, 517
TOTAL	1993	36, 33, 763

This table shows that an amount of Rs. 1823/- (36,33,763/1993) was collected

from the patients on an average at this hospital. A study done by Knaus and Davis in University Hospitals in US showed a case finding cost of USD 800 in 1998. [5] The case finding cost at this hospital's CT scan facility is very cheap when compared to those studies.

DISCUSSION

Cost Analysis: The values have been taken from data in the above tables.

Table 4: showing cost-benefit analysis of ct scan:

S. No.	Particulars	Amount (in Rs.)
1	Average number of scans done per month	332
2	Expense per month for the Workload	5, 83, 390
3	Revenue generated per each month	5, 98, 398
4	Expense per scan during the Study period	1756.5
5	Revenue generated per Scan	1801.5
6	Net Profit per month	6673.2
7	Net Profit per Scan	45

As seen in the above table, the institution is having a profit of Rs. 45/- per scan, which reflects the importance of having a cost analysis for this type of high tech investigative modalities. Though the study is not in similar lines of the one which McNeil did in 1997 which tells the number of hospital days saved, the dollars per year saved by having state of the art medical technology, this study highlights the facts of clinching the diagnoses with CT and treating the patient based on it, in turn saving the

patient from a prolonged stay in the hospital and also to prove that the equipment can be utilized properly with meager profits and thus be cost effective. [6]

Any improvement in diagnosis with CT scan imaging is achieved at a higher cost. Techniques for monitoring the cost benefit of this technology need to be used by every organisation. Cost benefit analysis attempts to assure that the disease is treated with the most minimal means available, which minimizes the cost of treatment. This

method involves such factors as the impact of CT on the existing health care system. Although cost benefit analysis is used for most systems of health care, it is very useful in imaging technology.

As Dr. R.D. Lele in 1988 in his editorial in JAMA commented that the medical profession in India should be particularly interested in the question of cost effectiveness of diagnostic tests as we are dealing with a predominantly poor class of patients. This aspect of cost optimisation was also stressed by Dr. K. K. Anand in 1990. [7, 8]

In 1985, John R Haga and Alfydi, in their study found in USA that every hospital of more than 200 beds had CT scan facility, which is in contrast to India, where they are usually attached to tertiary care teaching super-speciality hospitals. [9]

The study also focuses attention of the administrator to consider all aspects of CT scan facility before purchasing and installing such equipment as observed by Neil J. Prime in 1989. [10]

While constructing an establishment of Medical equipment it is important to consider a turnkey contract, as observed by Dr. Shakti Gupta and Lt. Col. Sunil Kant, as the agency takes the responsibility to set up the facility and train the staff and finally when it is handed over to the organisation it is functional in all senses.

CONCLUSION

Orloff et al in 2006, stressed the need for advanced costing techniques in order to shed light on cost based reimbursement by Medicare and other third party payers (i.e. Medical Insurance Companies). This study throws light on optimum utilisation of resources for effective achievement of goals of the capital investment. This study on cost-benefit analysis highlights some of the objectives of costing system. They are efficient to control costs, forecast the future

needs, matching the needs with costs, create cost consciousness among clinicians and other paramedical staff, fixation of charges, determine cost benefit ratio and to determine the expense of a product or service.

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How to cite this article: Kumar PN, Sharma S. Study on cost-benefit analysis of computerised tomography(CT) scan. Int J Health Sci Res. 2014;4(8):205-211.

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