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RESEARCH ARTICLE

COST ANALYSIS OF CATH LAB PROCEDURES DONE AT A TERTIARY CARE HOSPITAL OF NORTH INDIA

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Abstract

Cardiovascular Diseases in the community as a whole call for a detailed cost analysis of invasive procedures done in our hospital to have a broad over- view of financial implications these diseases have on people.

Methodology: A prospective observational study was carried out for a period of one year to do a cost analysis of invasive cardiac procedures done at our hospital.

Results: Costs were divided into direct and in-direct costs. It was found that CAG was the most expensive of all the procedures and material cost incurred was the highest followed by the rest.

Conclusion: A well planned team approach is needed to manage these cases within the financial reach of general masses.

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Introduction:-

Coronary artery disease is the leading cause of death all over the world. In the United States alone, over 1.2 million men and women every year suffer a coronary event, which is approximately 1 event every 26 seconds, causing 1 death every minute.(1,2)

Cardiovascular Diseases (CVD) and its complications most notably coronary heart disease (CHD), continue to be the major cause of premature deaths in the developed and developing nations like India. The cath. lab provides a number of invasive procedures that enable a cardiologist to check the heart & coronary arteries, measure blood flow & inter-cardiac pressure, assess how well the heart valves work, and check for structural defects. "Every day, more acute coronary syndrome more patients are at risk". So total health care costs may be thought of simplistically as the result of only two variables: "PRICE TIMES VOLUME".(3)

Cost improvement without reduction in patient services is a challenge for hospitals. Genuine cost improvement will be achieved when existing services will be rendered more cheaply and more efficiently. Cost accounting has found its application in hospitals for better assessment, planning and avoidance of wasteful expenditure.(4)

Keeping in view the importance of costing there was a need to do a cost analysis of various procedures done in our cath lab.

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Objectives:-

To do the cost analysis of invasive procedures done in cath. lab.

Study Design

An observational work study for a period of 4 weeks was undertaken prior to actual study and commenced as a source of preparation, pretesting & standardization before and to know about the various invasive procedures done in cath lab and they were grouped into groups as under:

Diagnostic Procedure	Interventional Procedure
CAG	PCI
Check Angio	Rescue PCI
Cath. Study	Device Closure
EPS	Renal Stenting
Renal Angio	PTMC
	PVBD
	CRTD
	Intra coronary stem cell therapy

A prospective study was undertaken for a period of one year from January 2021 to December 2022 in cath lab of our hospital. Taking sample size of 50% by simple random sampling, going to cath lab on three days in a week (50% of Working days), as Friday is maintenance day of cath lab and Sunday is off for staff so no procedure is done on these days.

The average cost per invasive procedure done in cath lab was calculated after adding following costs:

Direct Costs

Direct cost pertains to Material cost, Labour cost, Investigation cost, Drug Cost, Disposable cost, Machine depreciation cost, Maintenance cost of equipments.

1. **Material Cost:** it includes total average material cost per patient which includes expenditures incurred on materials like ECG electrodes, PM line, 6F sheath, Guiding wires, Diagnostic wires, Coronary angiography catheters like 6F JL-5, 6F JR.etc. It is calculated by multiplying the unit cost of each material used with the quantity consumed per patient.
2. **Labour Cost:** Calculation of labour cost involves estimating the expenditure on salaries incurred on doctors (Consultants, DM students & Senior Residents), technologists, technicians and nurses. The labour cost was calculated on the basis of actual number of personnel utilized and according to their time utilization. Full time was considered for nurses and accordingly their salary expenditure has been apportioned to the labour cost. An observational work study was conducted to know how much time all categories of doctors spend per patient in new cath lab. Accordingly, their time utilization and its cost has been apportioned to the labour cost, the salary particulars were obtained from accounts section of the hospital. For calculating labour cost basic pay, dearness allowance, HRA & city compensatory allowances were taken into consideration while as terminal benefits like gratuity, pension etc were not taken into account.
3. **Investigation cost:** Those investigations were considered which are included in pre cath and post cath. The cost of these investigations was taken as same as is being charged for outpatients.
4. **Drug cost:** It includes drug cost per patient which includes dye/ contrast, i.v. fluids, inj heparin, injerofiban, inj nicorandil etc. The average drug cost per patient was calculated by multiplying the unit cost of each drug with the quantity consumed per patient.
5. **Disposable cost:** It includes total average disposables used per patient like luerlock syringe, angiocath, gloves, general syringes, drip set etc.
6. **Machine depreciation cost:** The purchase cost of Axiom Artis fluoroscope cathlab table as mentioned in log books and supply orders were taken from Purchase Section of the hospital.
7. **Maintenance cost:** It was taken again from the Purchase Section of the hospital.

A) Indirect Costs

Indirect cost pertains to expenditure on Electricity, Building cost, Water cost, Indirect Labour cost and some Miscellaneous/other costs was calculated per hour.

1. Electricity cost: As there is no metered supply of electricity at our hospital. The cost of electricity was calculated on the basis of actual electric load of electrical gadgets as specified by the manufacturers. After taking diversity factor of 0.5, as per State SESU rates of Rs 700/- for 1st Kilowatt and Rs 900/- for further Kilowatts and electricity duty @ of 22% has been utilized for calculating cost of electricity consumption. The total electricity was calculated per month with the help of electrical engineering department. The electricity cost includes cost of electric consumption of cath.lab table, table lights, Air Conditioner and other small equipments like defibrillator, ACT machine etc.
2. Water cost: Based on average quantity of water consumption per day in new cath.lab and its offices on the basis of total no. of water taps and their water discharge per tap per hour. The State's prevailing rates in 2013 of PHE department were used to calculate water cost.
3. Building cost: The area occupied by new cath.lab was noted by actual physical measurement. The capital value on account of building and its fixed assets (plumbing & electrification) was calculated with the help of civil engineering department of our hospital. Assuming the life of building to be 100 years, the depreciation @ 1% on capital value annually was calculated whereas depreciation of fixed assets was calculated @ 5 % maintenance cost of building and its fixed assets was calculated on the basis of actual maintenance from civil engineering department
4. Indirect Labour cost: It includes salaries of pharmacist, security guard, sanitary attendants and casual labours working in new cath.lab.
5. Miscellaneous/ other cost: These include infrequent charges including stationary, linen, sanitation etc. Expenditure on these items has been estimated on the basis of actual monthly consumption and their price per unit.

Statistical Analysis

The continuous variables of the study have been shown in terms of descriptive statistics like mean, standard deviation, minimum and maximum. Also, the categorical variables in terms of frequency and percentage. Moreover, the appropriate statistical charts have been used to represent the data. Also, the coefficient of utilization has been calculated to see the utilization of the cath. lab. The statistical software SPSS version 20 has been used to analyse the data.

Results:-

To do the cost analysis of invasive procedures done in cath. Lab

Costs incurred on invasive procedure in cath lab were calculated under following heads:

1. Direct cost comprised of Material cost, Labour cost, Drug cost, Disposable cost, Investigation cost, Machine Depreciation cost, Maintenance cost.
2. Indirect cost comprised of Labour cost, Building cost, Water cost, Electricity cost, Miscellaneous cost.

Material cost:

The total material cost for the study period which includes ECG electrodes, PM line, 6F Sheath, Guiding wires, catheters, etc used in CAG and even stent cost used in PCI. (The stents used were of different companies and their rates varied) was Rs.14659471/- This comprised of 42.49% of total cost. Among different cost components the highest cost was incurred on Material which includes stent cost etc.

Labour cost:

The direct labour cost includes salaries of cardiologists, senior residents, technologist, technicians, and staff nurse. The total direct labour cost for the study period was Rs.11078118.88/- this comprised of 32.11% of total cost.

Drug cost:

The total drug cost includes inj. Iohexol (dye), inj. Heparin., inj. Tirofiban, etc. and unit cost of each multiplied with the quantity consumed per patient. The total drug cost for the study period was Rs.1138823.12/- this comprised of 3.30% of total cost.

Disposable cost:

The total disposable cost includes leurlock syringes, other general type of syringes, angiocaths, gloves, etc and unit cost of each multiplied with number of items used per patient. The total disposable cost for the study period was Rs.925046/- this comprised of 2.68% of total cost.

Investigation cost:

The investigations included in pre-cath. and post-cath. of patients were used to calculate investigation cost. The total investigation cost for the study period was Rs.653085/- this comprised of 1.89% of total cost.

Machine Depreciation cost:

Cost of Artis Axiom Cath. Lab (Siemens) when commissioned in February 2004 was Euro7, 65000/- 1Euro= Rs 51 (in 2004), thus value was Rs.39, 015,000/-(3 crore 90 lakh & 15 thousand). The equipment would depreciate at rate of 10% per year. Using the straight line diminishing balance method, the depreciation value of equipment for the study period was worked out as Rs.1679467.82/- this comprised of 4.87% of total cost.

Maintenance cost:

Machine was under warranty for first 2 years. Comprehensive Maintenance Contract was done in March 2012 as follows:

03/07/12 to 02/07/13 @ Rs.2434469/-per year and revised w.e.f.

03/07/13 to 02/07/15 @ Rs.2483159/- per year.

Thus, maintenance cost for the study period was Rs.1862369.16/- this comprised of 5.40% of the total cost.

Indirect Cost:**Labour cost:**

Indirect labour cost includes salaries of the pharmacist, security guard, sanitary attendant and casual labours. The total indirect labour cost for the study period was Rs.1737774/- this comprised of 5.04% of total cost.

Building cost:

The rental value for New Cath. Lab building is Rs.40250/- per month and for the study period is Rs.209300/- this comprised of 0.61% of total cost

Water cost:

The total water cost for the study period @ Rs. 70/day (2025litres/24 hours) was Rs. 10920/- this comprised of 0.03% of the total cost.

Electricity cost:

The electricity cost includes cost of electricity consumption of Cath Lab Table, defibrillators, Tube lights, Air conditioning, etc. The electricity cost for the study period was Rs. 140400/- this comprised of 0.41% of total cost.

Miscellaneous cost:

This includes infrequent charges like cost of stationery, cssd items etc. The total miscellaneous cost for the study period was Rs.410150/- this comprised of 1.19% of total cost.

Therefore,

Total cost of any invasive procedure done in cath. lab

= A (Direct cost) + B (Indirect cost)

Number of procedures done

=Rs.31996380.98+2508544.00/631

=Rs. 34504924.98/631

=Rs. 54682.92/-

The direct cost accounts for 92.73% of the total cost and indirect cost accounts for the 7.27% of the total cost.

CAG in this study costs Rs. 7823/- to the patient while as PCI costs Rs.60193/- to the patient. This depicts cost borne out of pocket of the patient who undergoes any procedure in cath. lab of our hospital. (Table 2)

Minimum cost of CAG is Rs.6054/- and maximum cost is Rs.10951/- which is out of pocket of the patient. Minimum cost of PCI is Rs.8642/- and maximum cost is Rs.225315/- which is out of pocket of the patient. This includes cost of stent also. Minimum cost of CATH STUDY is Rs.6054/- and maximum cost is Rs.9341/- Minimum cost of CRTD is Rs.224377/- and maximum cost is Rs.559892/- which includes cost of device also. (Table 3).

Mean cost incurred to the hospital for CAG is Rs.25903/- Mean cost incurred to the hospital for PCI is Rs.27506/- similarly for other procedures done in cath. lab mean cost distribution is shown in Table 4.

Table 1:- Distribution of types of cost in rupees and percentage contributed to total cost incurred on invasive procedure in cath. lab.

Type of Cost	Cost in Rs	%age
Labour Cost	11078118.88	32.11
Material Cost	14659471.00	42.49
Drug Cost	1138823.12	3.30
Disposable Cost	925046.00	2.68
Investigation Cost	653085.00	1.89
Machine Depreciation Cost	1679467.82	4.87
Maintenance Cost	1862369.16	5.40
Direct Cost (In Rs)	31996380.98	92.73
Indirect Cost (In Rs)		
Indirect Labour Cost	1737774.00	5.04
Building Cost	209300.00	0.61
Water Cost	10920.00	0.03
Electricity Cost	140400.00	0.41
Miscellaneous Cost	410150.00	1.19
Indirect Cost	2508544.00	7.27
Total Cost (in Rs)	34504924.98	
Avg. Cost per procedure	54682.92	

Table 1a:- Distribution of cost (%) incurred on procedures in cath. Lab.

Distribution of Direct & Indirect Cost	Percentage (%)
Labour Cost	32.11
Material Cost	42.49
Drug Cost	3.30
Disposable Cost	2.68
Investigation Cost	1.89
Machine Depreciation Cost	4.87
Maintenance Cost	5.40
Indirect Labour Cost	5.04
Building Cost	0.61
Water Cost	0.03
Electricity Cost	0.41
Miscellaneous Cost	1.19
Total	100.00

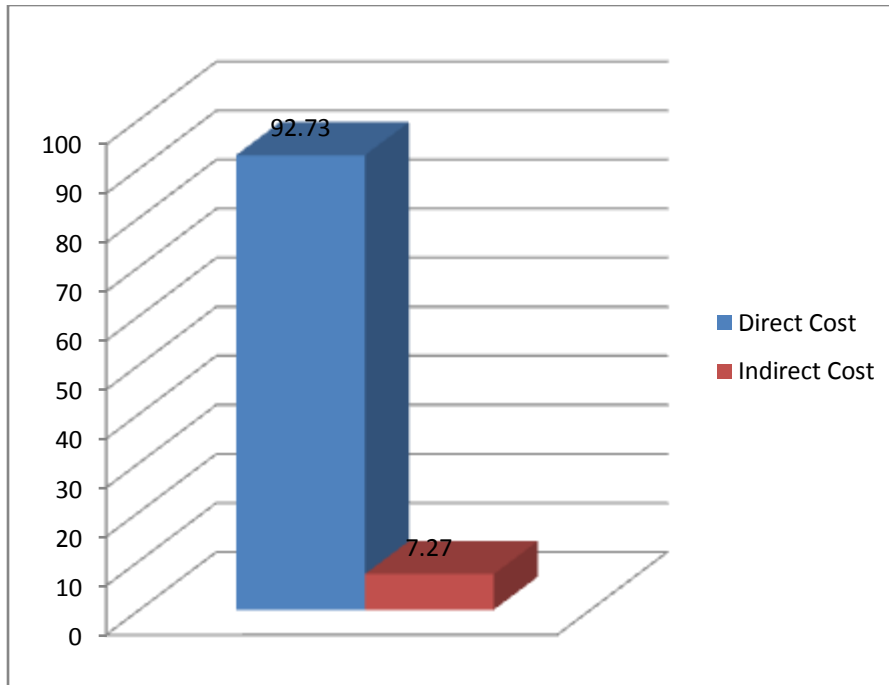


Figure 1:- Components of cost incurred on procedures.

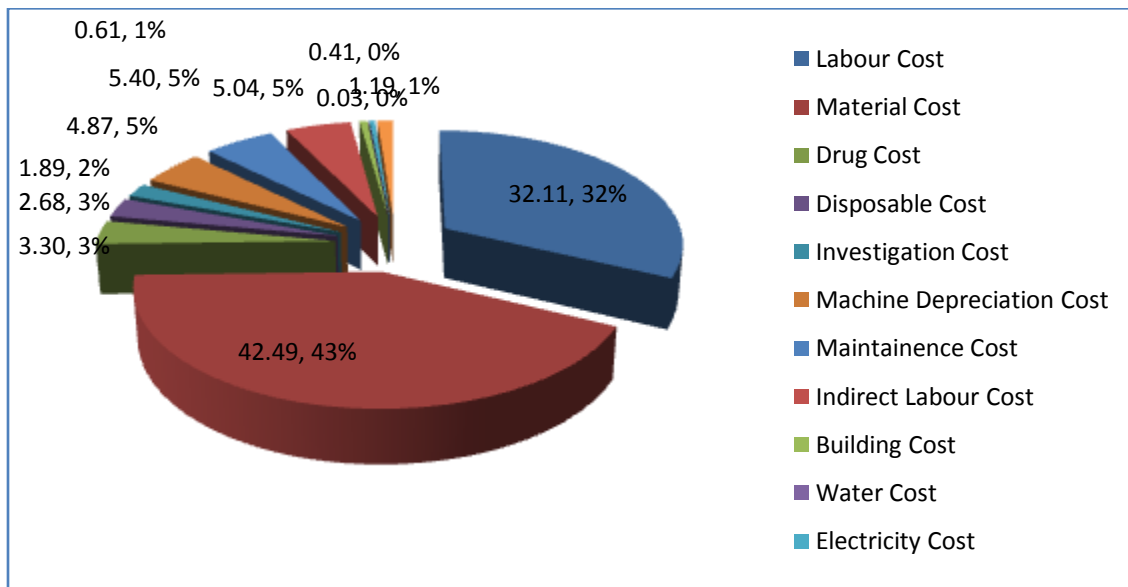


Figure 2:- Costs incurred on procedures in cath. lab (%).

Table 2:-Cost (in Rs.) incurred to the patient per procedure which is out of pocket.

Procedure	No. of patients	Cost in Rupees	Standard Deviation
CAG	316	7823.00	751.311
PCI	211	60192.96	47501.312
Cath study	22	7770.73	932.516
EPS	21	10314.70	10104.259
Device closure	11	85972.66	39083.405
RAG	26	7304.51	1043.653
PTMC	14	25556.73	21728.237
PVBD	4	21261.80	22926.438

CRTD	4	476013.55	167757.500
Stem cell therapy	2	8333.89	2064.752
Total(in INRupees)	631	30205.27	53383.323

CAG in this study costs Rs. 7823/- to the patient while as PCI costs Rs. 60193/- to the patient. This depicts cost borne out of pocket of the patient who undergoes any procedure in cath. lab of our hospital. (The distribution is shown in Table 2).

Table 3:-Details of Cost incurred to the hospital for procedures done in cath lab.

Procedure	No. of Patients	Mean Cost (in Rs)
CAG	316	25903.24
PCI	211	27490.65
Cath study	22	25903.24
EPS	21	25903.24
Device closure	11	27505.84
RAG	26	25903.24
PTMC	14	27505.84
PVBD	4	27505.84
CRTD	4	27505.84
Stem cell therapy	2	25903.24
Total	631	26517.87

Mean cost incurred to the hospital for CAG is Rs.25903/-

Mean cost incurred to the hospital for PCI is Rs.27506/- similarly for other procedures done in cath. lab distribution is shown in Table 3.

Table 4:-Table showing total cost (Hospital + Out of Pocket) for different procedure:

The total cost per procedure incurred to any patient in our hospital is depicted in Table 4.

S No.	Procedure	No. of Patients	Hospital Cost (in Rs)	Cost to Patient (in Rs)	Total Cost per Procedure (in Rs)	Total cost in USD
1	CAG	316	25903.24	7823	33726.24	532.4
2	PCI	211	27490.65	60192.96	87683.61	1384.1
3	Cath study	22	25903.24	7770.73	33673.97	531.6
4	EPS	21	25903.24	10314.7	36217.94	571.7
5	Device closure	11	27505.84	85972.66	113478.5	1791.3
6	RAG	26	25903.24	7304.51	33207.75	524.2
7	PTMC	14	27505.84	25556.73	53062.57	837.6
8	PVBD	4	27505.84	21261.8	48767.64	769.8
9	CRTD	4	27505.84	476013.55	503519.39	7948.2
10	Stem Cell Therapy	2	25903.24	8333.89	34237.13	540.4
	Total	631	26517.87	30205.27	56723.14	895.4

1USD = 63.2 Rs.

Thus, the average cost per procedure is Rs.56723/- which is \pm Rs. 2040 from the cost calculated by actual Cost Accounting Method (Rs.54683/-)

Discussion:-

Cost finding and analysis are of value to management in ensuring that costs do not exceed available revenues and subsidies.(5)Although over 1 million procedures are performed in cardiac catheterization laboratories (CCLs) annually, little comparative data exist on costs or resource use in these settings.

In this study total cost of CAG is Rs 33726.24 (\$ 532.4) comparable with Cohen DJ et al6 LHC (\$ 306), PTCA (\$ 3172); PCI (Stenting) is Rs 87683.6 (\$ 1384), Device Closure is Rs 113478.5 (\$ 1791.3); CRTD is Rs 503519 (\$ 7948.2) and the average cost per patient irrespective of any procedure is Rs 56723.14 (\$ 895.4). Becker ER et

al(7)revealed the following details in their study:LHC (\$308), RHC (\$ 395), PTCA (\$ 841), Coronary Stent (\$ 3186); PTCA (\$ 2938±859), Stenting (\$3781 ±745).

Material cost was highest in this study i.e Rs.23232(\$369) (42.9 %) followed by labour cost (32.11 %) and average cost per patient irrespective of any procedure is Rs 54682.9 (\$863.2) by actual cost accounting. David J et al showed material cost was highest (\$ 1169±567) for PTCA and (\$2220±582) for stenting. Sukin CA,etal showed largest component of cost was found to be Material Cost (cost of device, stent, etc.)(8,9)

The overall treatment cost although less in developing countries because of lower staff salaries and lower cost of drugs, is still 10 to 20 times higher than the percapita gross national product and remains out of reach of the most of the coronary population. Cost of stenting in India varies from 1.25 lakhs to 1.50 lakhs in Govt. Hospitals and in corporate hospitals it can vary from 2.5 to 5.0 lakh rupees.

Conclusion:-

It is well recognised, that hospital charges may not reflect the true economic costs of a procedure and to determine the cost-effectiveness of new invasive techniques in cardiac cath. lab, it was necessary to start with careful assessment of their actual costs. Therefore, the present study was undertaken to provide better understanding of actual costs. True economic costs are best determined as the marginal costs of all the resources consumed in producing a good or service. Determination of true hospital costs therefore required detailed analysis of each patient's resource consumption.

Abbreviations:

CVD	Cardiovascular Disease
CHD	Coronary Heart Disease
PCI	Percutaneous Coronary Intervention
ACC	American College of Cardiology
AHA	American Heart Association
CABG	Coronary Artery Bypass Grafting
AMI	Acute Myocardial Infarction
CCL	Cardiac Catheterization Laboratory
CTO	Chronic Total Occlusion
LHC	Left Heart Catheterization
PTCA	Percutaneous Transluminal Coronary Balloon Angioplasty
CAG	Coronary Angiography
PCI	Percutaneous Coronary Intervention
EPS	Electrophysiology Study
RAG	Renal Angiography
PTMC	Percutaneous Transvenous Mitral Commissurotomy
PVBD	Pulmonary Valve Balloon Dilatation
CRTD	Cardiac Resynchronization Therapy Device

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