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RESEARCH ARTICLE

ACTIVITY BASED COST ANALYSIS OF DIAGNOSTIC AND THERAPEUTIC PROCEDURES PERFORMED IN THE NUCLEAR MEDICINE DEPARTMENT OF A TERTIARY CARE TEACHING HOSPITAL

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ABSTRACT

Introduction: The rising disease burden worldwide has posed enormous pressure on healthcare to provide cost-effective treatment. In this scenario, it becomes imperative for hospitals to efficiently utilize the resources and there is requirement of accurate cost analysis of healthcare procedures. Role of Nuclear Medicine has become indispensable in diagnosing and prognosticating varied number of diseases. So that necessitates a balanced utilization of such procedures when the resources are limited. ***Aim:*** To analyze the unit cost of diagnostic and therapeutic procedures performed in Nuclear Medicine department of a tertiary care teaching hospital. ***Material and Method:*** It was an observational, descriptive and cross sectional study carried out in the Nuclear medicine department of Sheri-Kashmir Institute of Medical Sciences for a period of one year. Activity based costing method was used to evaluate and analyze the unit cost of various diagnostic and therapeutic procedures ***Results:*** The unit cost of procedures performed in the Nuclear medicine department varied from Rs.1190 for RAIU (Radioactive Iodine Uptake) to Rs.11075 for High dose I-131 therapy. The most cost effective investigation was found to be cardiac MIBI scan with a unit cost of Rs. 2893.2 followed by bone scan when compared with tariffs of other Nuclear Medicine facility. It was found that the study hospital is already providing most of the nuclear scan services at much subsidized rates and the rates haven't been revised since many years. ***Conclusion:*** ABC methodology provides a structured approach in analyzing activities, cost services, reducing costs, and improving quality.

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INTRODUCTION

In recent years, a striking shift in the causes of mortality and morbidity has taken place across the world. Chronic and non-communicable diseases, especially cardiovascular disease and cancer, are now leading causes of mortality. Given these demographic changes and the rising impact of chronic diseases, the role of Nuclear Medicine in disease management is becoming more salient, and its potential impact is no longer limited to any particular region of the world. Nuclear medicine helps not only to diagnose diseases but is also used for multiple therapeutic purposes and is a safe and effective way of obtaining information that would otherwise be unavailable, or can only be obtained by intrusive riskier techniques such as surgery and biopsies. However with the advances in improved nuclear medicine care, escalation of costs is a reality, jeopardizing the accessibility of the procedures for the patients. [1] Cost information helps health planners allocate resources to facilities and services, [2] introduce or set user fees, [3] assess the comparative efficiency of health care services across settings, [4] and determine budgets to run health services.

Cost information on different aspects of health care is extremely important and useful to health planners and decision makers, especially hospital administrators, to make more evidence based decisions in planning and management. The need for an accurate method of costing in hospital organizations is frequently emphasized by many authors. Indeed, various costing methods are used to allocate department direct costs to patients, and there is a lack of standardization. [5] Cost components are identified either at the aggregate level (gross costing) or at the patient level (micro-costing). Then, cost components are valued either by allotting costs from comprehensive sources (top-down approach), or by identifying resource consumption at the patient level (bottom-up approach). Top-down micro-costing results in average unit costs per patient, whereas bottom-up micro-costing (also called as Activity based costing) leads to patient specific unit costs. Under ABC, costs are accumulated for activities that consume resources and then are applied to products (procedures/patients) on the basis of the activities required in their production (treatment). It provides more accurate cost information than do conventional costing systems for health-care industries. This study was conducted to analyze the cost of various procedures

performed in the Nuclear medicine department of a tertiary care teaching hospital using Activity Based Costing (ABC).

OBJECTIVE

- To analyze the unit cost of diagnostic and therapeutic procedures performed in Nuclear Medicine department of a tertiary care teaching hospital.

METHODOLOGY

This study is an observational, descriptive and cross sectional study carried out in the Nuclear medicine department of a tertiary care teaching hospital over a period of one year. The department being studied performs both diagnostic as well as therapeutic procedures and it is comprised of two NM Physicians, one Scholar, one Technologist, one Nurse and one Nursing Aid. The study analyzes costs related to various diagnostic and therapeutic procedures using Activity Based Method (ABC). Ethical clearance for the study was obtained from the Institutional Ethics Committee (IEC) of the study hospital. The study population was stratified into groups based on the specific scan type, and one-third of the patients who underwent each of these procedures were selected by simple random sampling such that the selection was entirely by chance and hence a sample size of 1143 patients was created for analysis purposes. There were no exclusion criteria. All the patients who were referred for procedures by respective physicians constituted the study population. A time motion study was conducted to estimate the time taken for various procedures, equipment run time and time spent by the different cadres of staff for the procedures performed at each step. Cumulative labor hours and equipment hours were then derived by adding the labour hours and equipment hours observed at each step of the procedure being studied.

Different costs were categorized into direct and indirect costs. The direct costs included Material Cost, Machine/Equipment depreciation cost and labour cost while the indirect costs included Cost on account of electricity, Maintenance cost and other overhead costs.

Material cost per procedure =
(Avg. No. of milliCurie of radioisotope used X Cost of 1 milliCurie) + Cost of cold kit used

Machine/Equipment Depreciation cost: Cost of the equipment and year of its purchase was obtained from the Purchase section of the hospital. The Equipment depreciation cost was calculated by Accelerated Depreciation Method (Double Declining Balance Method).

Equipment depreciation cost =
(Depreciation for the study period / working minutes in study period) **X** Time of scan (minutes)

Labour cost per procedure =
(Monthly salary of the concerned personnel / working minutes in a month) **X** Time spent on the procedure (minutes)

Electricity cost per procedure =
(Cost of electricity per month / working minutes per month) **X** Time spent on the procedure (in minutes)

Maintenance cost of the equipment was not included as it was part of Annual maintenance contract (AMC).Overhead costs viz. water cost, stationary cost, laundry and linen cost and furniture cost were excluded in view of their negligible contribution. The total unit cost per procedure was calculated in the end by summing up all the direct and indirect costs.

RESULTS

A total of 1143 procedures performed in the department of nuclear medicine department were studied which included both diagnostic and therapeutic procedures. Tc 99m MDP bone scan (37.2%) was the most frequent scan done during the study period followed by Tc 99m pertechnate thyroid scan(18.7%), Tc 99m DTPA scan (11.8%) and others scans (Table1). The unit cost of procedures performed in the Nuclear medicine department varied from Rs.11075 for High dose I-131 therapy to Rs.1190 for RAIU (Radioactive Iodine Uptake). (Table2). Material cost contribution towards the nuclear scan services was the highest which was followed by labour cost and equipment depreciation cost. Electricity cost had the least contribution. Fig. 1

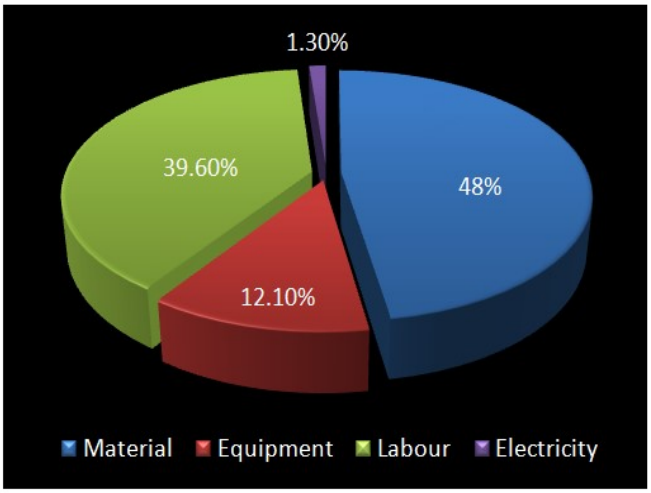

Figure 1. Allocation of costs to cost centers

Table 1. Nuclear Scan of Study Patients

Nuclear Scan	Percentage (%)
I-131 High dose therapy	2.5
I-131 Low dose therapy	1.0
I-131 whole body scan	5.0
RAIU	3.4
RBC scan	0.1
Tc 99m Cardiac MIBI Scan	1.6
Tc 99m DMSA scan	3.7
Tc 99m DTPA scan	11.8
Tc 99m EC scan	8.0
Tc 99m MDP bone scan	37.2
Tc 99m Mebrofenin Hepatobiliary Scan	2.8
Tc 99m Meckels Diverticulum scan	0.3
Tc 99m MIBI Parathyroid scan	3.8
Tc 99m Pertechnate Thyroid scan	18.5
Tc 99m sulphur colloid liver spleen scan	0.3

DISCUSSION

Hospital operating expenses are at the core of the growing gap between required and available resources. A lot of health expenditure is wasted through misallocation and by technical and managerial inefficiency within the hospitals. Information on the costs and outputs of hospitals can provide considerable information for managers of hospitals, regional coordinators of health services, and policy makers overseeing the issues of the national health system.[6]

The purpose of our study was to see the spectrum of the procedures, diagnostic as well as therapeutic, being done in Dept. of Nuclear medicine and analyse their unit cost as there are limited number of studies in the literature till date on the subject. The unit cost analysis was done for various procedures in NM dept. using reliable, standardised activity based costing calculation method (ABC). In our study, we collected data of 1143 number of patients who reported to Department of Nuclear Medicine of a tertiary care hospital over a period of twelve months. Tc 99m MDP bone scan, Renal scans (Tc 99m DMSA scan, Tc 99m DTPA scan, Tc 99m EC Scan) and Tc 99m Pertechnate thyroid scan, were the commonest scans performed in our NM department which is consistent with the data from other developing nations.[1,7] Bone scan being the most common followed by renal scans and Thyroid scans.

Table 2. Costs of the nuclear scans/procedures observed during the study period

Nuclear Scan	Cost Variables (INR)				Total Cost (INR)	SKIMS Tariff (INR)
	Material	Equipment	Labour	Electricity		
MDP Bone Scan	990 (45.4%)	186.49 (8.5%)	981.91 (45.1%)	18.42 (0.84%)	2176.8	400
DTPA Renal Scan	220 (12.5%)	437.10 (24.9%)	1047.96 (59.9%)	43.20 (2.47%)	1748.7	300
DMSA Renal Scan	237.7 (16.3%)	218.55 (14.9 %)	980.12 (67.2%)	21.60 (1.48%)	1457.97	500
Renal EC Scan	424.5 (21.9%)	437.10 (22.5%)	1030.12 (53.2%)	43.20 (2.23%)	1934.92	500
Thyroid Scan	135 (11.0%)	218.55 (17.9%)	844.12 (69.2%)	21.6 (1.79%)	1219.27	300
Parathyroid Scan	990 (42.8%)	291.40 (12.6%)	999.28 (43.2%)	28.80 (1.24%)	2309.48	650
Cardiac MIBI Scan	990 (34.2%)	364.25 (12.5%)	1502.95 (51.9%)	36.0 (1.24%)	2893.20	3000
Meckels Diverticulum Scan	405 (18.7%)	437.10 (20.2%)	1277.88 (59.0%)	43.2 (1.99%)	2163.18	300
Mebrofenin Hepatobiliary Scan	267 (13.7%)	582.8 (29.9%)	1038.98 (53.3%)	57.6 (2.95%)	1946.38	350
Sulphur colloid liver spleen Scan	307 (20.6%)	291.40 (19.6%)	858.08 (57.7%)	28.8 (1.9%)	1485.28	300
RBC GI bleed Scan	990 (36.6%)	582.8 (21.5%)	1072.80 (39.6%)	57.6 (2.13%)	2703.20	300
Low dose I-131 therapy	2525 (73.1%)	0 (0%)	927.88(26.8%)	0 (0%)	3452.88	1000
High dose I-131 therapy	9250 (83.5%)	291.4 (2.6%)	1504.98 (13.5%)	28.8 (0.26%)	11075.18	3500
RAIU	305 (25.6%)	18.60 (1.5%)	852.18 (71.6%)	14.40 (1.2%)	1190.18	300

However, in an Armed Force Medical College (AFMC) Pune based study, it was observed that the majority of the procedures in their NMU were cardiac myocardial perfusion imaging (MPI) scans followed by renal and bone scans, respectively.[8] As per J. R. Ballinger, the two widely used NM studies were found to be MPI and bone scintigraphy.[9] It is pertinent to mention here that the most cost effective investigation was found to be cardiac MIBI scan with a unit cost of Rs. 2893.2 at the study hospital, whereas the same was priced at Rs. 4963.1 in another nuclear medicine centre studied by Hada , *et al*.[8] A significant difference in unit cost was found with the Bone scan as well (Rs 2176.3 vs Rs3835.3). However, the unit cost of our Thyroid scan was found to be Rs 1219.27, which was more than the rate of other studied hospital (Rs. 869.94).[8] Figure 2

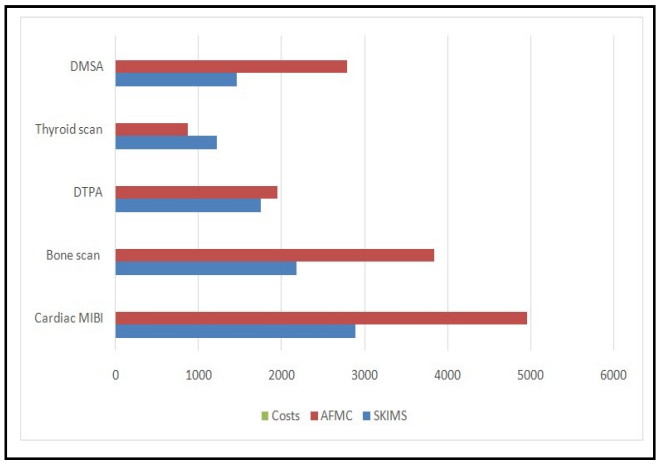

Figure 2. Comparison of unit cost of major scans at our study hospital and AFMC, Pune

ABC analysis applied in our study suggests that the cost of radiopharmaceutical material and operational time (Equipment running time and labour time) constitute major proportion towards per procedure cost.S Suthumanon , *et al*. in their study also found that the operational time and the cost of drugs have the most influence on the cost of procedure.[10]The major cost contribution towards the nuclear scan services was by material cost (48%) followed by labour cost (39.6%) and equipment depreciation cost (12.1%). Electricity cost contributed the least (1.3%) (Figure1). Equipment maintenance cost was virtually nil as the equipment were under Annual Maintenance Contract. Hada MS, *et al*. in their study also observed that significant expenditure was being incurred towards procurement of consumables (including radioactive material) at their centre, amounting to approximately 29% of the total expenditure.[8] However, equipment maintenance cost was prohibitively high in their study (8.38%). A significant cost reduction can be achieved towards radioactive materials with the adoption of certain practices like proper scheduling of patients and adherence to such schedule, indigenization of equipment and consumables, cost awareness program for clinicians and utilization reviews to prevent wastage of radioactivity.

On the other hand, there is also a scope of hiking rates of the nuclear scan services as the study hospital is already providing most of the nuclear scan services at much subsidised rates and the rates haven't been revised since many years.

CONCLUSION

Based on this Activity based cost analysis, the hospital seems to experience a loss from most of the nuclear scans. Hence, a revision of the nuclear scan rates is warranted. Although, ABC system is a time-consuming, labour-intensive process, and its success depends on the total participation of every unit of an organization, it provides a structured approach in analysing activities, cost services, reducing costs, and improving quality.

Recommendation

A significant cost reduction can be achieved towards radioactive materials with adoption of certain practices like:

- The scheduling can be made more compact, time management initiatives can be initiated so as to properly utilize the infrastructure and equipment and also prevent loss of radioisotope activity. This can make the pricing / costing more economical and number of procedures can be increased per day.
- The nuclear medicine equipment is mostly imported and the costs are quite high especially taking taxes etc. into consideration. If a medical device company can indigenize the equipment, the costs can be brought down considerably.
- As the radioisotopes are flown by air, it increases the freight costs. Availability of local production of radioisotopes/improved uninterrupted supply can improve the efficiency and reduce the costing of procedures.
- Cost awareness programs are a need of time across all areas of health care delivery so as to increase the efficiency and profitably of work.

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