Original Article

Activity based costing of diagnostic procedures at a nuclear medicine center of a tertiary care hospital

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ABSTRACT

Context: Escalating health care expenses pose a new challenge to the health care environment of becoming more cost-effective. There is an urgent need for more accurate data on the costs of health care procedures. Demographic changes, changing morbidity profile, and the rising impact of noncommunicable diseases are emphasizing the role of nuclear medicine (NM) in the future health care environment. However, the impact of emerging disease load and stagnant resource availability needs to be balanced by a strategic drive towards optimal utilization of available healthcare resources. **Aim:** The aim was to ascertain the cost of diagnostic procedures conducted at the NM Department of a tertiary health care facility by employing activity based costing (ABC) method. **Materials and Methods:** A descriptive cross-sectional study was carried out over a period of 1 year. ABC methodology was utilized for ascertaining unit cost of different diagnostic procedures and such costs were compared with prevalent market rates for estimating cost effectiveness of the department being studied. **Results:** The cost per unit procedure for various procedures varied from Rs. 869 (USD 14.48) for a thyroid scan to Rs. 11230 (USD 187.16) for a meta-iodo-benzyl-guanidine (MIBG) scan, the most cost-effective investigations being the stress thallium, technetium-99 m myocardial perfusion imaging (MPI) and MIBG scan. The costs obtained from this study were observed to be competitive when compared to prevalent market rates. **Conclusion:** ABC methodology provides precise costing inputs and should be used for all future costing studies in NM Departments.

Keywords: Activity based costing, cost effectiveness, nuclear medicine

INTRODUCTION

Nuclear medicine (NM) is one of the fastest growing specialties in the world and has evolved as a tool for individualization of patient care and for improvement of health care outcomes. Clinical NM has progressed beyond its own boundary into new domains of diagnostic radiology and oncology with the ever-increasing use of integrated structure-function imaging.[1]

There has been a considerable shift in the morbidity and mortality profile of the population across the world in recent times, wherein the leading causes of mortality include chronic and noncommunicable diseases, especially cardiovascular diseases and cancer. The changes in lifestyle coupled with increasing life expectancies and corresponding increases in the aging population have brought the developing world even closer to the developed world in terms of the incidence of health problems. Demographic changes coupled with the rising impact of chronic diseases, is widening the role of NM in management of the diverse group of diseases in various parts of the world.[2]

Conducting cost analysis help hospitals understand how much it costs them to provide healthcare services. The information obtained from cost analysis also help the organizations operate more cost effectively as well as monitor and control costs where necessary. It also helps hospitals to improve quality and efficiency of care they provide and manage their resources better.[3] However, published studies on costing of NM procedures are few in number, pointing to a lacuna in knowledge on this issue.

Resource management and optimal resource utilization in hospitals has gained a significant importance in today's global economy, resulting in the traditional accounting systems becoming inadequate and sub-optimal for managing hospital resources and accurately determining service costs.[4]

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Traditional cost accounting uses broad averages for assigning the cost of resources uniformly to procedures or services, when individual procedures may be using these resources in a nonuniform manner. While traditional costing allocates overhead and indirect costs in proportion to production volume or to direct costs, such costs are directly traced in activity based costing (ABC) techniques to activities or services through tracing methods, resulting in a more accurate estimate of unit costs than the traditional costing technique.[5]

This study was conducted to ascertain the cost of performing different diagnostic procedures by the NM Department of a tertiary Care Government Teaching Hospital by utilizing ABC methodology of costing.

MATERIALS AND METHODS

This study is an observational, descriptive and cross-sectional study carried out over a period of 12 months at a NM Centre of tertiary care multi-specialty Government Teaching Hospital, where patients are investigated and treated for free. The center under study has two fulltime NM physicians, one fulltime NM technician and one part-time Safaiwala. The study entails classifying costs, identifying cost drivers and tracing all costs related to various diagnostic procedures performed at the NM Centre by using ABC costing method.

Initially, the patients undergoing diagnostic procedures and the staff administering these procedures were observed by the study team to develop adequate process literacy. Ethical clearance for the study was obtained from the Institutional Ethics Committee of the Study Hospital.

Time motion study was conducted to estimate the direct labor hours, that is, the time required by the staff for performing each type of procedure and equipment run time was calculated on the basis of the mean time required for conducting various diagnostic procedures using various equipments available with the center. Cumulative labor hours and cumulative machine hours were thus calculated by adding the relevant observed times for each type of procedures [Table 1].

The cost of technetium was calculated based on the quantity of radioactivity utilized by various procedures. Various records were perused for ascertaining specific input costs, e.g. staff salary slips were used for estimation of salary and wages and departmental and hospital inventory books for estimation of the inventory. Various rates of Hospital Engineering Services were used for estimation of equipment maintenance and repair charges. The Municipal Corporation water rates and State Electricity Boards tariff rates were used for estimation of water and electricity usage charges and prevalent land utilization rates were used for estimating the rental value of the building.

Straight-line depreciation was utilized to estimate the depreciated value of equipments, whereas comprehensive annual maintenance contract rates were accepted towards the calculation of cost for equipment maintenance.

Table 1: The various procedures and their relevant details

Name of procedure	Number of procedures performed during the study period	Labor time/ procedure (min)	Equipment time/ procedure (min)
MPI scan (MIBI)	651	90	60
DTPA renogram	476	45	30
Bone scan	474	120	30
Thyroid scan	164	30	30
Stress thallium	92	90	30
DMSA renogram	78	90	30
Misc procedures	141		
Cumulative total	2076	166,935	80,030

MPI: Myocardial perfusion imaging, MIBI: Methoxyisobutylisonitrile, DTPA: Diethylene-triamine-pentaacetic acid, DMSA: Di-mercapto-succinic acid

The cost of various supplies and consumables was estimated from the receipt vouchers and the rate contract documents. Prevalent market rates were taken for calculation and ascertaining certain overhead expenses such as stationery, laundry, and various supply items like clothing and furniture.

The various costs calculated were thereby traced to their respective cost drivers, cost driver being a variable, such as level of activity or volume, that usually affects costs over a given time span and has a cause and effect relationship between a change in level of activity or volume and a change in the level of costs[5] and total expenses under various heads were calculated [Table 2]. The costs thus obtained from the study were compared with that prevailing at a private tertiary care hospital located in the same city and Central Government Health Scheme (CGHS) rates.

Idle time cost of professionals, cost of biomedical, radiological and general waste disposal and apportioned cost of administration and management of the center were not included in the study.

RESULTS

A total of 2076 investigations were conducted at the NM department during the study period, which included newly registered cases as well as follow-up of old cases. The majority of procedures were observed to be cardiac myocardial perfusion imaging (MPI) scans followed by renal and bone scans, respectively [Figure 1], the total number of procedures being 9.23% more than that of the previous year.

The total expenses towards operating this NM Department, subsequent to tracing of each cost driver were found to be Rs. 7,202,450 [Table 2]. The major cost centers contributing to the total expenses were observed to be staff salaries, equipment run and maintenance costs and costs of medicines and consumables [Figure 2]. The cost per unit procedure for various diagnostic procedures varied from Rs. 869 for a thyroid

scan to Rs. 11,230 for a meta-iodo-benzyl-guanidine (MIBG) scan in this center [Table 3].

Table 2: Tracing of various costs to suitable cost drivers

Cost variables	Cost activity	Cost driver	Total expenses (Rs.)
Direct cost			
Direct labor			
Man-hour cost	Direct labor	Direct labor hours	2,810,000
Drugs-specific consumables			
Radionuclide			
Technetium	Direct material	Number of procedures	1,114,200
Iodine-131			18,063
Thallium-201			152,000
Tracer (tagging agent)			620,730
Drugs like injection lasix, injection adenosine			77,628
Supplies			19,875
Electrodes			
Equipment	Direct expenses	Direct equipment hours	1,398,020
Building	Direct expenses	Direct labor hours	87,872
Overhead cost			
Stationary	Indirect expenses	Number of procedures	7860
Equipment maintenance	Indirect labor	Direct equipment hours	603,607
Water charges	Indirect expenses	Number of procedures	9390
Electricity charges	Indirect expenses	Direct equipment hours	152,809
Rental value	Indirect expenses	Direct equipment hours	22,708
Building maintenance	Indirect expenses	Direct equipment hours	40,627
Laundry charges	Indirect material	Number of procedures	7620
Furniture cost	Indirect material	Direct equipment hours	15,451
Linen cost	Indirect material	Direct equipment hours	9661
Common consumables			
Intracath, syringes, cotton, spirit	Indirect material	Number of procedures	34,329
			Rs. 7,202,450

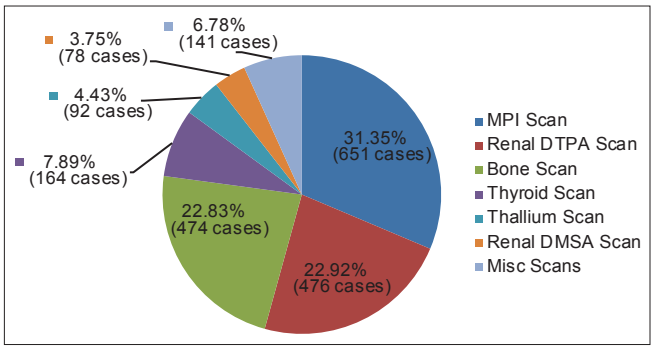

Figure 1: Major investigations carried out from January 01, 2012 to December 31, 2012

The cost of major procedures carried out in the NM department being studied was then compared with that of a private tertiary care hospital located in the same city and CGHS rates and found to be competitive in respect of prevailing market rates [Figure 3].

DISCUSSION

Activity-based costing is an approach to service costing that differs from traditional costing methods because of the way it assigns costs. Traditional costing methods assigns costs using an allocation process that has little bearing to the reason costs were incurred initially.[6] Instead of collecting costs by category (e.g. people costs, occupancy, supplies) and then arbitrarily allocating them to cost centers or products, ABC technique identifies various activities performed, traces costs to these activities and then uses various cost drivers to trace the cost of activities to the final service, cost drivers being factors that reflect consumption of activities by product or service.[7]

A total of 2076 investigations were carried out during the study period out of which nearly 31% were MPI scans followed by renal and bone scans, pointing toward the increasing morbidity load because of noncommunicable diseases. As per J. R. Ballinger, the two widely used NM studies were found to be MPI and bone scintigraphy.[8]

The cost of unit procedures being conducted by the NM Department varied as per different resource inputs for each procedure, thyroid scans costing Rs. 869, MPI scans Rs. 4963 (USD 82.71) and MIBG scans Rs. 11,230 respectively.

The total costs incurred in running this center during the study period were Rs. 7,202,450, out of which the total direct and total indirect expenses were Rs. 6,298,388 and Rs. 904,062 respectively. The total expenses incurred towards the salary and wages of the staff was Rs. 2,810,000, which amounted to nearly 39% of the total expenses and provides a direction towards future efforts towards cost-containment by optimizing direct labor utilization.

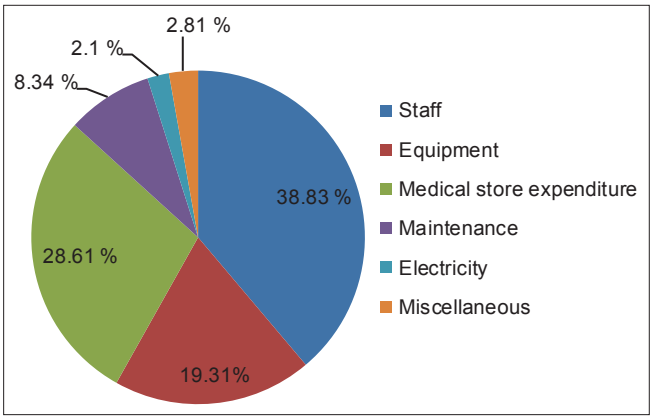

Figure 2: Allocation of all costs to cost centers

Table 3: Costs of the most common investigations conducted at this center

Cost variables	MPI scan (MIBI)	Renal DTPA scan	Renal DMSA scan	Bone scan	Tc-99 m thyroid scan	Stress thallium	MIBG scan
Direct labor	1514.96	757.48	1514.96	2019.94	504.98	1514.96	2019.94
Direct supplies	26.75	0	0	0	0	26.75	0
Direct drugs-specific consumables	1670.71	294.45	359.45	880.26	31.49	1652	7444
Building	47.37	23.68	47.37	63.16	15.79	47.37	63.16
Equipment	1048.12	524.06	524.06	524.06	174.68	524.06	1048.12
Equipment repair and maintenance	452.53	226.27	226.27	226.27	75.42	226.27	452.53
Electricity charges	114.56	57.28	57.28	57.28	19.09	57.28	114.56
Water charges	4.52	4.52	4.52	4.52	4.52	4.52	4.52
Office supplies-stationary	3.78	3.78	3.78	3.78	3.78	3.78	3.78
Linen cost	4.65	4.65	4.65	4.65	4.65	4.65	4.65
Furniture cost	7.44	7.44	7.44	7.44	7.44	7.44	7.44
Building maintenance	30.46	15.23	15.23	15.23	5.08	15.23	30.46
Rental value of building	17.02	8.51	8.51	8.51	2.83	8.51	17.02
Laundry	3.67	3.67	3.67	3.67	3.67	3.67	3.67
Common consumables	16.52	16.52	16.52	16.52	16.52	16.52	16.52
Total cost (Rs.)	4963.06	1947.54	2793.71	3835.29	869.94	4113.01	11230.37
Total cost (USD @ 1 USD=Rs. 60)	82.71	32.49	46.56	63.92	14.49	68.55	187.17

MIBG: Meta-iodo-benzyl-guanidine, MPI: Myocardial perfusion imaging, MIBI: Methoxyisobutylisonitrile, DMSA: Dimercaptosuccinic acid, DTPA: Diethylene-triamine-pentaacetic acid

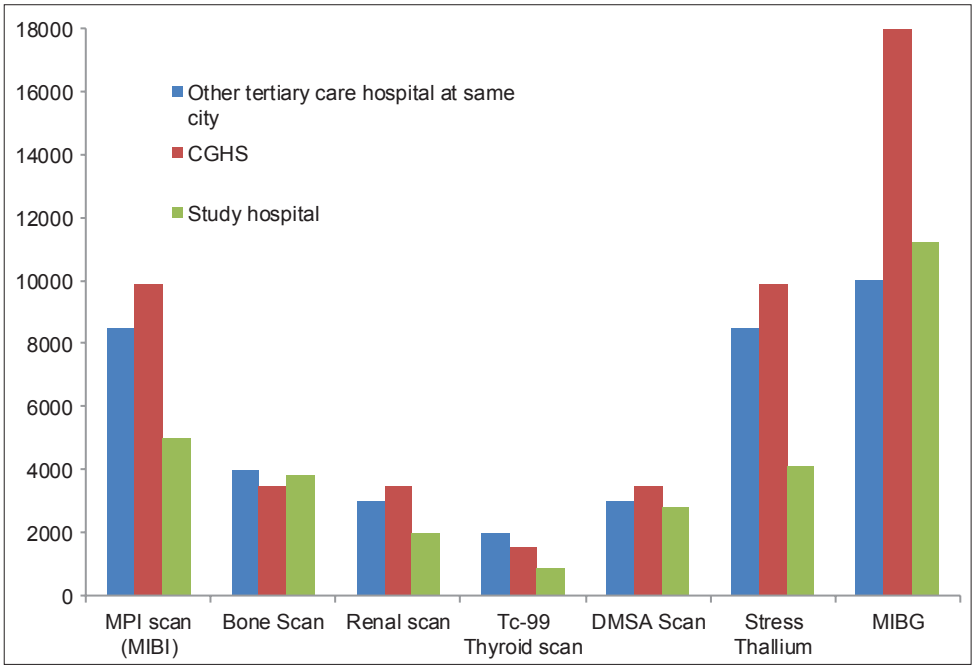

Figure 3: Comparison of cost of major cases

Significant expenditure was being incurred towards procurement of consumables by this center, amounting to approximately 29% of the total expenditure. A significant reduction can be achieved in the expenses towards consumables with the adoption of certain practices like proper scheduling of patients and adherence to such schedule, sharing of radioactivity with other local NM Centers for overflow optimization among such centers, indigenization of equipments and consumables, cost awareness program for clinicians and utilization reviews to prevent wastage of radioactivity.

The cost of equipment maintenance (8.38%) is prohibitively high, which can be brought down substantially through training of the staff in the first line maintenance of equipments, leading to reduction in the cost of Comprehensive Annual Maintenance Contract. Similarly, energy conservation and regular audit will lead to saving of electricity, which is a major contributor towards procedure costing.

When the cost of diagnostic procedures calculated was compared with the market rates being charged by private hospitals located in the same city as well as CGHS rates, unit cost of procedures like stress thallium, renogram scans and MPI scan were found to be significantly lesser and very competitive.

The unit costs of various diagnostic procedures were found to be competitive, when compared against prevalent market rates.

The most cost effective investigation was found to be stress thallium scan with a unit cost of Rs. 4113.00 (USD 68.55) in this center, whereas the same was priced at Rs. 8500.00 (USD 141.67) and Rs. 9900.00 (USD 165) respectively at the private hospital and CGHS rates, respectively. Another significant difference in price was found with the MIBG scan, which was estimated at Rs. 11230.00 (USD 187.17) per procedure, whereas the same was priced at Rs. 10,000.00 (USD 166.67) and Rs. 18,000.00 (USD 300), respectively at the private hospital and CGHS rates. However, the cost of bone scan was found to be Rs. 3835.00 (USD 63.92), which was more than the rates of CGHS (Rs. 3500.00), but lesser than that of private hospital (Rs. 4000.00).

The advantage of using ABC costing technique is that it provides management with logical and precise cost information and once available, this information can be used to chart a plan of action. When incorporated into critical management systems, it can serve as a powerful tool for continuously rethinking and dramatically improving products and services, processes, and market strategies.[9]

Costing of various diagnostic procedures conducted at the NM Department in the present study provides a precise costing knowledge that can be utilized for establishing a profitable pricing policy as well as institute measures towards cost containment of prominent cost drivers of the study hospital, thus making the hospital the best process owner in the market.

An annual increase of 9.23% was observed in the number of diagnostic procedures being performed by the center. The benefits of diagnostic imaging are immense and the increased sophistication and clinical efficacy of imaging have revolutionized the practice of medicine, resulting in dramatic growth over the past quarter century. The hazards associated with expanding use of imaging modalities using ionizing radiation can be minimized by preventing the inappropriate use of such imaging and by optimizing studies that are performed to obtain the best image quality with the lowest radiation dose possible.[10]

The principal attributes of ensuring patient safety are clinical acumen, mastery of technology and dedication to safety and quality.[11] Efforts such as education for all stakeholders in the principles of radiation safety, appropriate utilization of imaging to minimize any associated radiation risk, standardization of radiation dose data to be achieved during imaging and identification of alternative imaging of patients who may have already reached threshold levels of estimated exposure from diagnostic imaging will be necessary in future for enhancing patient safety in the operations of NM procedures.

This study suffers from certain limitations in ignoring certain overhead costs incurred towards security and general administration. Moreover, a note of caution is mandated due to the complicated and time consuming methodology of ABC costing, which may not be easy to perform by the uninitiated.

CONCLUSION

Nuclear medicine procedures not only carries a high cost but also subjects the patients to a risk of radiation exposure, thus raising the all-important question of economics and patient safety. Utilizing ABC costing routinely in the NM Department will provide precise costing of various diagnostic procedures being performed by such departments, leading to effective cost containment measures. Moreover, managerial strategies towards maximizing efficiency, optimizing resources and minimizing waste will go a long way in making NM procedures affordable and accessible to all sections of the Indian society, thus pointing to the necessity of periodic costing exercises in every NM Department.

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