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ORIGINAL ARTICLE

An Assessment of Diagnostic Equipment Utilization in a Tertiary Healthcare Setup: A Key to Economical Patient Management

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ABSTRACT

Equipment utilization management is the evaluation of the medical equipment necessity, appropriateness, and efficiency of the use in the healthcare services or procedures. The investment on an equipment is said to be a good one if it shows a utilization coefficient of 50% or above.

The study was descriptive observational in nature and was conducted in the Histopathology Department, PGIMER, Chandigarh. The data for the entire year of 2012 was collected by studying various records of the department including purchase files, inventory registers, log books and service records of medical equipments.

The results indicated that the Utilization Coefficients of various diagnostic equipments in the department of Histopathology, PGIMER, Chandigarh for the year 2012 were in the order of 58.1, 62.1 and 60.4% for high cost, medium cost and low cost equipments respectively.

On an average, the utilization coefficient of medical equipments under study (Year 2012) of the Histopathology Department, PGIMER, Chandigarh, was found to be 60.2% (above 50%). This figure reflects that the budget spent on average medical diagnostic equipment in this department is very much justifiable. The study also showed that the cost incurred on various cost categories of diagnostic equipments, i.e. the low, medium and high cost equipments was also equally important.

Keywords: Low, Medium and high cost diagnostic equipments, Utilization coefficient, Break down, Equipment down time and daily work load.

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INTRODUCTION

Hospitals have undergone a quantum change in concept and care provisioning from ancient days to present era. The information explosion and technological advances have revolutionized the medical care. The sophistication in the medical field has led to the development of specialized care centers in an attempt to provide high quality care. Modern medical technology has contributed immensely in improving the quality of healthcare and state of health profile of nations. The advancement has been mainly due to: improved diagnostic facilities; sophisticated equipments, and spectacular progress in development in surgical procedures.[1]

The introduction of state of art technology has resulted in metamorphic changes in diagnostic and therapeutic modalities in patient care activities. This has led to enhancement of quality of life and decreased morbidity and mortality rates.[1]

Medical equipments contribute to almost 40 to 50% costs in a tertiary hospital setup. The medical equipment though cutting edge at the time of purchase poses threat of inevitable obsolescence within 6 to 7 years of installation. This problem is compounded by the fact that most of such equipments are imported and very few local reputed manufacturers exist in India. This leads to putting higher treatment costs and further to lesser competitive edges and low utilization rates resulting in undesired operating margins.[2]

The availability and utilization of various healthcare equipments at all levels in the health system for effective and efficient service delivery, was also emphasized in the Alma-Ata declaration at the International Conference on Primary Health Care in 1978, which was later included into the strategy of Health for all by 2000 AD.[3]

Medical equipment is an integral part of the physical infrastructure of a healthcare setup. It is an important means of providing various services to the people. So, in a way it can be said that these equipments are of utmost importance and have become a necessity in almost all activities whether diagnostic, therapeutic, or supportive in nature.[3]

Many costly medical equipments are lying in the hospitals which are either never installed or are out of order for want of spares or proper maintenance. These types of

happenings are very common and most of the big government hospitals are plagued with this problem, which not only gives bad publicity to the hospital administration but also leads to wastage of scarcely available resources of the country. Proper planning of medical equipment in a hospital will not only economize on resources but will also result in availability of maximum equipment in functional state all the time.[4]

Most of the states and other organizations in India have laid down rules and regulations for the procurement of equipments and other supplies in the hospitals. The basic rationale behind all these rules, regulations and procedures is to maximize the value of the money invested in the purchase of equipment.[5]

It should be the earnest endeavor of the management and the users to optimize the equipment utilization to obtain maximum returns for the capital invested. In an era of cost-intensive medical care, every equipment being installed in healthcare institutions need to be fully and properly utilized.

An optimum utilization of equipment will result in as follows:

- Optimum patient handling and rapid turnover.
- Minimum possible cost of healthcare.
- Quality patient care and satisfaction.

Utilization essentially means the use of the equipment to the full potential.[5]

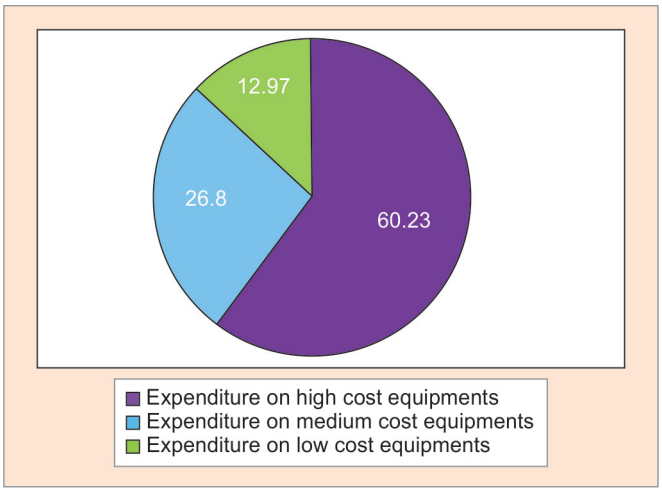
As of now for the smooth functioning of any healthcare facility that is from primary health center to a tertiary care institute effective management as well as maintenance play a major part.[6]

AIMS AND OBJECTIVES

1. To enumerate the various diagnostic equipments used in random in various sections of the department.
2. To categorize them into the low, medium and high cost equipments based on their procurement cost.
3. To find the utilization coefficient of these equipments individually during the year 2012 (January 2012 to December 2012) for 12 months.

MATERIALS AND METHODS

The study was conducted in the Histopathology Department, PGIMER, Chandigarh. PGIMER, Chandigarh is a medical education and research institute. It has educational, medical research and training facilities for students of various categories other than imparting tertiary healthcare services in North India. The tools and techniques applied in the study are presented in Table 1.



Graph 1: Percentage of expenditure on medical equipments

RESULTS AND ANALYSIS

Analysis of Objective 1

To enumerate the various diagnostic instruments used for random in the various sections of the department, a final list of 50 medical diagnostic equipments were selected for the study as presented in Table 2.

There are mainly ten sections of the Department of Histopathology equipped with sophisticated medical diagnostic equipments according to the requirement of laboratory investigations. An average number of five equipments was selected from each section for the study.

Analysis of Objective 2

This section analyses the cost categorization and the percentage of expenditure incurred on these medical diagnostic equipments (Table 3 and Graph 1).

Based on the procurement cost, these medical diagnostic equipments were categorized into the low, medium and high cost equipments as presented in Table 3. For this purpose, the inventory and stock registers of the department were studied for the purchase orders of the equipments under study and their procurement costs were recorded. A final list of 30 medical equipments of different cost categories used for various techniques/purposes was prepared. These included 10 each of low, medium and high cost medical diagnostic equipments.

On analyzing the cost of these medical equipments, it was also observed that most of the equipments were of foreign origin and their procurement costs were available as per the respective foreign currency and hence they were converted into Indian currency, i.e. rupees to make the study simple and comparable.

On analyzing the data, it was observed that out of total expenditure of ₹ 4,64,87,345/-, 60.23% (₹ 2,79,99,328/-)

Table 1: Tools and techniques employed

Purpose/Objective	*Preliminary analysis*
Tools and techniques used	Observation methods (study of records mentioned in log books, inventory/stock register of each medical equipment under study) Frequencies charts Tabulation presentations Pie charts
Purpose/Objective no. 1	To enumerate the various diagnostic equipments in different sections of the department.
Tools and techniques used	For this objective, four-step methodology was followed *Step 1*: A complete list of all medical equipments used in the various sections of the department was prepared. *Step 2*: These were arranged as per their locations, i.e. various sections/labs of the department. *Step 3*: Major diagnostic equipments from each section were selected by stratified random sampling method. *Step 4*: A total no. of 50 medical diagnostic equipments were selected for the study.
Purpose/Objective no. 2	To categorize them into the low, medium and high cost equipments based on their procurement cost.
Tools and techniques used	All the medical diagnostic equipments under study were categorized into three as per their procurement cost as follows: Low cost (Procurement cost less than 5 Lakhs) Medium cost (Procurement cost falling between 5 and 10 Lakhs) High cost (Procurement cost more than 10 Lakhs)
Purpose/Objective no. 3	To find the utilization coefficient of these equipments individually during the year 2012 (January 2012 to December 2012) for 12 months.
Tools and techniques used	Utilization coefficient was calculated using the following formula Utilization coefficient = (A*B/C*D)*100 Here, 'A' the no. of days the medical equipment was actually used during the year 2012. For this, time period of the equipment down time was calculated and deducted from total working days ('C'). 'B' the no. of hours the equipment was actually used for a working day (average time taken by a procedure on that equipment, * average no. of procedures performed in a working day). Time taken for each procedure was asked and daily work load status was observed from the log books of all the months of 2012. The technologists were also enquired as to the uses/functions of the medical diagnostic equipments under study. 'C' the no. of days the medical equipment could have been available (if there was no down time and the equipment was put in working order). For this, PGIMER Calendar of the year 2012 was taken to find out the total no. of working days as follows: Total no. of days in 2012 = 366 (2012 being the leap year) Total no. of sundays in 2012 = 53 Total no. of gazetted holidays = 17 Total no. of OPD holidays = 11 Hence, total no. of working days were = 366 – (53+17+11) = 285 days So, 'C' was taken as 285 days for all the calculations. 'D' the no. of hours the medical diagnostic equipment could have been available in a working day (if there was no equipment down time and the equipment was put in working order). There were total 233 full working days (Monday to Friday; working timings 9 am to 5 pm and 1 hour lunch break) and 52 half working days (Saturdays). Total working hours = (233*7) + (52*4) = (1631 + 208) = 1839 hours Hence, average total working hours in a day was 6.45 hours (1839/285). So, 'D' was taken as 6.45 working hours on daily basis for the calculation of utilization coefficient of medical equipments.

was spent on high cost medical equipments, 26.8% (₹ 1,24,58,608/-) was spent on medium cost equipments and the remaining 12.97% (₹ 60,29,409/-) was spent on the low cost medical equipments (Graph 1).

Analysis of Objective 3

The utilization coefficient of these medical diagnostic equipments were calculated individually for the year 2012 (January 2012 to December 2012) as per the formula stated in the methodology and is presented in Table 4.

Results of the above calculations were based on the criteria that if the utilization coefficient was less than 50%, it was considered to be under-utilized and hence not a good investment and *vice versa*. However, life-saving equipments cannot be subjected to this kind of assessment.

Percentage Utilization Coefficient of Medical Diagnostic Equipments

The average percentage of utilization coefficient of different cost categories of medical diagnostic equipments is presented in Graphs 2 to 4.

Table 2: Selection of medical diagnostic equipments section wise

Sl. no.	*Name of the departmental section/lab (location of equipment)*	*Quantity of medical diagnostic equipments selected for the assessment of equipment utilization coefficient*
1.	EM Lab	01
2.	Grossing lab	05
3.	Processing lab	06
4.	Microtomy lab	06
5.	Staining lab	06
6.	Immunohistochemistry lab	04
7.	Molecular lab	05
8.	Reporting lab	08
9.	EM processing lab	05
10.	Cryo/Frozen lab	04
	Total	50

Table 3: Expenditure spent on medical diagnostic equipments

Sl. no.	*Name of medical equipment*	*Department section/lab (location of equipment)*	*Procurement cost per unit in* ₹	*Cost category low/ medium/high*	*Qty.*	*Total procurement cost in* ₹
1.	Transmission electron microscope	Electron microscope lab	94,52,570	High	01	94,52,570
2.	Thermo-shandon work station	Grossing lab	11,22,000	High	02	22,44,000
3.	Autopsy saw with HEPA bone dust collector	Grossing lab	1,14,000	Low	01	1,14,000
4.	Bone saw	Grossing lab	5,73,800	Medium	02	11,47,600
5.	Automated tissue processor with fume exhaust system	Processing lab	9,40,929	Medium	02	18,81,858
6.	Rapid multifunctional microwave tissue processor	Processing lab	11,12,162	High	01	11,12,162
7.	Embedding consol system	Processing lab	2,27,000	Low	02	4,54,000
8.	Fully enclosed tissue processor	Processing lab	18,10,500	High	01	18,10,500
9.	Rotary microtome	Microtomy lab	6,53,112	Medium	02	13,06,224
10.	Automatic microtome knife sharpener	Microtomy lab	5,57,000	Medium	02	11,14,000
11.	Automated microtome	Microtomy lab	6,60,700	Medium	02	13,21,400
12.	Autostainer	Staining lab	10,53,000	High	02	21,06,000
13.	Binocular research microscope	Staining lab	3,56,440	Low	04	14,25,760
14.	Automated immunostainer	Immunohistochemistry lab	13,41,000	High	01	13,41,000
15.	Antigen retrieval system decloaking chamber	Immunohistochemistry lab	1,22,700	Low	01	1,22,700
16.	Cold centrifuge	Immunohistochemistry lab	3,74,563	Low	02	7,49,126
17.	PCR machine with microfuge	Molecular lab	4,46,600	Low	02	8,93,200
18.	*In situ* hybridizer	Molecular lab	4,81,442	Low	01	4,81,442
19.	Gel documentation system	Molecular lab	3,68,410	Low	02	7,36,820
20.	Trinocular research microscope	Reporting lab	3,90,000	Low	01	3,90,000
21.	Binocular research microscope with dual viewing attachments	Reporting lab	7,36,925	Medium	02	14,73,850
22.	Binocular research microscope (ten header)	Reporting lab	7,85,580	Medium	02	15,71,160
23.	Image analyzer fully automatic for DMRB microscope	Reporting lab	6,78,500	Medium	01	6,78,500
24.	Binocular research microscope for transmitted light with photomicrography attachment camera	Reporting lab	17,80,399	High	02	29,11,800
25.	Digital imaging system for TEM 906 consisting of CCD camera	Em processing lab	19,54,560	High	01	19,54,560
26.	Ultramicrotome and accessories	Em processing lab	29,11,800	High	01	29,11,800
27.	EM automated tissue processor	Em processing lab	9,40,929	Medium	01	9,40,929
28.	Diamond knife	Em processing lab	5,11,662	Medium	02	10,23,324
29.	Ultra low deep freezer	Cryo/frozen lab	3,31,840	Low	02	6,63,680
30.	Cryostat with UV disinfection system	Cryo/frozen lab	10,76,690	High	02	21,53,380
Total expenditure = ₹ 4,64,87,345/-						

The average utilization coefficient of high cost medical equipments is 58.10% (Graph 2), for medium cost medical equipments is 62.10% (Graph 3) and that of low cost medical equipments is 60.40% (Graph 4).

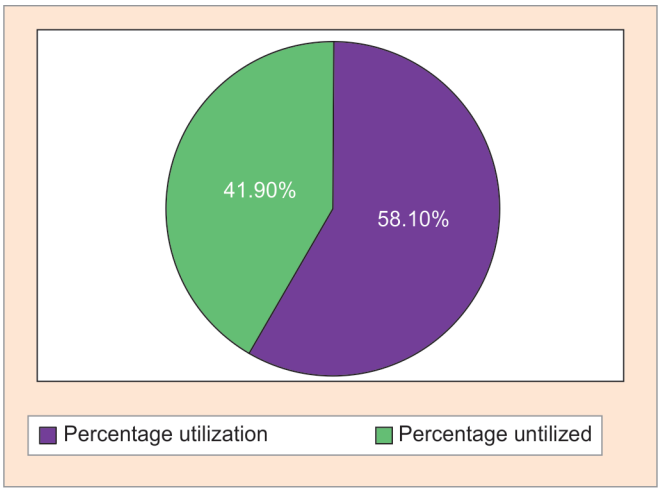
DISCUSSION

The hospital spends a heavy sum of money on the procurement of state of the art equipment every year as per the needs and demands stated by the various departments of the hospital. Most of them have to be imported from foreign countries. Thus efficient utilization of such equipments is a major area of concern and also formed the basis of this study.

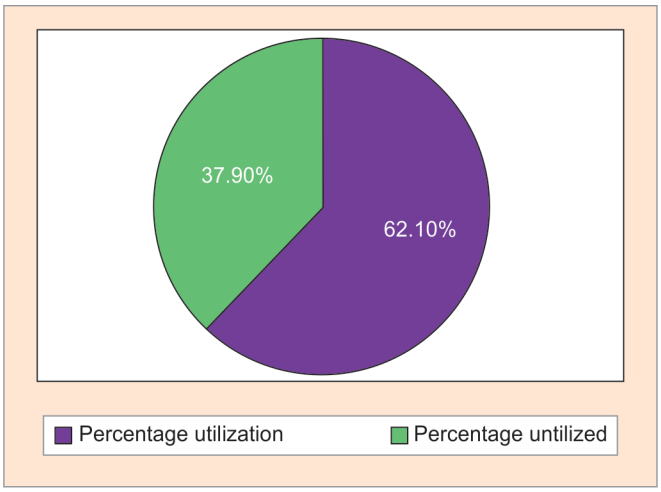
Planning and acquisition of medical equipments is a continuous process. Decision-makers are seldom trained or have the awareness of modern technology. These persons may not be responsible for its eventual operation and maintenance. There is a lack of coordination among agencies involved in various processes, from demand generation to procurement, finance and maintenance. Investment and recurring costs are nonsustainable. Equipment selection is not done as per the morbidity pattern or skills available to make the best use of the equipment but rather for prestige, craze for the latest and the best. If a hospital does not have a systematic purchase and maintenance plan for the medical equipments, it can lead to high cost, inadequate and improper utilization of the equipment. So, it has become mandatory to become the cost conscious and to be assertive of the cost benefits. Cost reduction is needed to be effected without affecting the quality and effectiveness of the services. Moreover, the medical equipments have applications only for the patients and have an impact on human lives and therefore, need to be dealt with in quite a different manner as compared to the other industries. It is imperative to assess its operative functionality and utilization by equipment audit, maintenance and repair. Hospital and clinical administrators are also faced with the expectation for return on investment that meets accounting guidelines and financial pressures.

Table 4: Utilization coefficient of medical equipments under study (Year 2012)

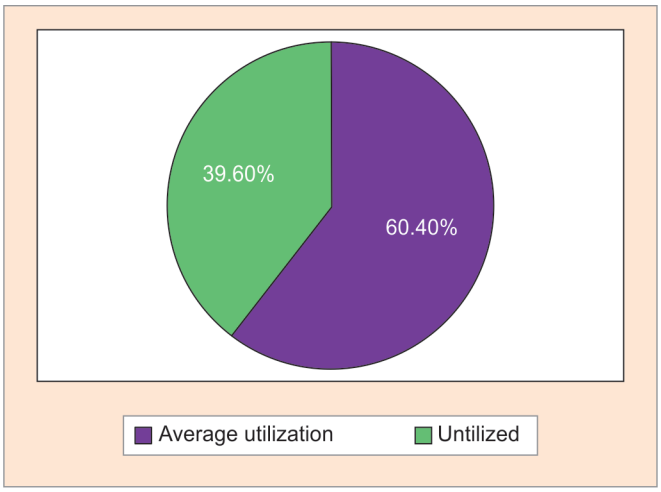
S. No.	*Name of medical equipment*	*Department section/lab*	*Cost category low/medium/high*	*Utilization coefficient (%)*
1.	Transmission electron microscope	Electron microscope lab	High	69.8
2.	Thermo-Shandon work station	Grossing lab	High	74.8
3.	Autopsy saw with HEPA bone dust collector	Grossing lab	Low	52.7
4.	Bone saw	Grossing lab	Medium	54.3
5.	Automated tissue processor with fume exhaust system	Processing lab	Medium	55.6
6.	Rapid multifunctional microwave tissue processor	Processing lab	High	55.8
7.	Embedding consol system	Processing lab	Low	75.3
8.	Fully enclosed tissue processor	Processing lab	High	61.0
9.	Rotary microtome	Microtomy lab	Medium	83.6
10.	Automatic microtome knife sharpener	Microtomy lab	Medium	31.0
11.	Automated microtome	Microtomy lab	Medium	54.3
12.	Autostainer	Staining lab	High	77.8
13.	Binocular research microscope	Staining lab	Low	50.0
14.	Automated immunostainer	Immunohistochemistry lab	High	40.0
15.	Antigen retrieval system decloaking chamber	Immunohistochemistry lab	Low	54.3
16.	Cold centrifuge	Immunohistochemistry lab	Low	47.7
17.	PCR machine with microfuge	Molecular lab	Low	70.0
18.	*In situ* hybridizer	Molecular lab	Low	43.4
19.	Gel documentation system	Molecular lab	Low	36.6
20.	Trinocular research microscope	Reporting lab	Low	74.4
21.	Binocular research microscope with dual viewing attachments	Reporting lab	Medium	77.5
22.	Binocular research microscope (Ten header)	Reporting lab	Medium	85.3
23.	Image analyzer fully automatic for existing DMRB microscope	Reporting lab	Medium	34.1
24.	Binocular research microscope for transmitted light with photomicrography camera	Reporting lab	High	35.6
25.	Digital imaging system for TEM 906 consisting of CCD camera	Em processing lab	High	62.0
26.	Ultramicrotome and accessories	Em processing lab	High	52.7
27.	Em automated tissue processor	Em processing lab	Medium	93.0
28.	Diamond knife	Em processing lab	Medium	52.7
29.	Ultra low deep freezer	Cryo lab	Low	100
30.	Cryostat with UV disinfection system	Cryo lab	High	51.2



Graph 2: Average utilization coefficients of high cost medical equipments



Graph 3: Average utilization coefficients of medium cost medical equipments



Graph 4: Average utilization coefficients of low cost medical equipments

In addition to the above mentioned bottlenecks, the hospital is a matrix organization and it definitely increases the challenges faced by the hospital administrators right from the time the equipment is procured to its optimum utilization.

CONCLUSION

The high cost medical equipments showed an average utilization coefficient of 58.1%, medium cost categories equipment showed 62.1% and that of low cost categories was 60.4%. Thus, on an average the utilization coefficient of medical equipments under study (Year 2012) of the department of histopathology, PGIMER, Chandigarh was found to be 60.2%.

On an average, the utilization coefficient of medical equipments under study (Year 2012) of the Department of histopathology, PGIMER, Chandigarh, was found to be 60.2% (above 50%). This figure reflects that the budget spent on average medical diagnostic equipment in this department is very much justifiable.

The study also showed that the cost incurred on various cost categories of diagnostic equipments, i.e. the low, medium and high cost equipments was also equally important since each category of medical equipment was used to an equal potential.

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