ORIGINAL RESEARCH PAPER

Volume-7 | Issue-6 | June-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

UTILIZATION STUDY OF MAGNETIC RESONANCE IMAGE SCANNER IN A TERTIARY CARE TEACHING HOSPITAL

Hospital Administration

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ABSTRACT

Background: MRI facility is a costly technology center in health care business. The right managerial decision increases the productivity of MRI. The utilization studies of such costly equipment is essential. Estimating the use coefficient of an equipment is useful for health care manager as a management tool.

Objectives: The study was focused to estimate the workload of MRI scanner, to analyze the utilization hours and find out utilization coefficient (UC) of MRI.

Methods: It was an observational and cross-sectional study carried out in teaching tertiary care hospital. The number of scans performed in the duration six years collected. The average time taken for a scan was estimated. The MRI equipment was operated for 14 hours per day. The equipment operating hours were calculated over a period of one month. The utilization co-efficient index was calculated.

Results: The total number of MRI scans were 38036 in six years. The time for each type of scan was estimated. The total scanning time for 691 MRI scans was 15460 minutes and 47 seconds, in one month. The turnaround time was 5528 minutes for 691 scans. The total time was 20988 min. 47 sec. The average time MRI operated was 11hours and 39 min. the UC of MRI was 48.54%.

Conclusion: The audits revealed that in many hospitals equipments were underutilized. Estimating UCI of all equipments is helpful to enhance the utilization rate of high end equipment for policy decisions in the public hospital.

KEYWORDS

MRI, Use Coefficient Index.

INTRODUCTION

The India Brand Equate Foundation (2018), which was an initiative of the Ministry of Commerce and Industry, Government of India stated, " India's health care industry growth is increased and stood at Rs 4 trillion (US$ 61.79billion) in 2017 and expected to increase 16-17 percent (at Compound Annual Growth Rate) to reach Rs. 8 trillion (US$ 132.84 billion) by 2023." "There is the immense and alarming demand of the capital investment for high-end diagnostic services in India. To encourage medical infrastructure in India, Union Cabinet approved budget support of Rs 85,271 crore (US$ 13.16 billion) for the period of April 2017- March 2020 under National Health Mission." Nishith Desai Associates (2016) found that the growth of health care was not impacted by the economic shut down of other industries. This sector expected the growth of US$ 280 billion by 2020. Equipment (Pandit and Unadkat 2017) is defined as "all items necessary for the functioning of all services of the facility, including such services as accounting and records, maintenance of buildings and grounds, laundry, public waiting room, health and related services." In WHO Medical Devices technical series (2011) it was explained that, "the Medical device as an article, instrument, apparatus or machine that is used in the prevention, diagnosis or treatment of illness or disease, or for detecting, measuring, restoring, correcting or modifying the structure or function of the body for some health purpose and its purpose is not achieved by pharmacological, immunological or metabolic means." "Medical equipment: Medical devices requiring calibration, maintenance, repair, user training, and decommissioning-activities usually managed by clinical engineers. Medical equipment is used for the specific purposes of diagnosis and treatment of diseases or rehabilitation following disease or injury; it can be used either alone or in combination with any accessory, consumables, or the other piece of equipment. Medical equipment excludes implantable, disposable or single –use medical devices." "Medical technology includes all hospital equipments used for the diagnosis, therapy, monitoring, rehabilitation, and care." Sedzi (2016) has stated that the effective medical technology management is required for efficient utilization of equipments to ensure continued high-quality patient care.

Chaudhary and Kaul (2014) have revealed that hospitals have undergone a quantum of changes in providing quality medical care. Advanced medical technology has contributed immensely the high quality healthcare, by providing sophisticated diagnostic services. The availability and utilization of medical equipment 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 incorporated into the strategy of Health for all by 2000 AD. Most costly medical equipments are lying idle in many hospitals, which are either never installed or out of order for want of spares or proper maintenance or medical technologist non availability. Doyle (2015) and Mathew et al., (2016) have explored that, public health services facilitated with Computed Tomography (CT) and Magnetic Resonance (MR) scanners to take high-quality images of tissues and internal organs, which are critically useful for clinicians' decisions for medical care. These equipments occupy a large ratio of investment in a hospital. These equipments are responsible for a considerable financial risk to heath care provider due to high purchase and maintenance cost and short life cycle of seven years to 10 years. The approximate cost of the MRI scanner US$ 1.5 to 4.5 million, and maintenance cost is US$150000 to 20000 per year. Because of poor medical equipment management practices in public health services, lack of proper planning at the health-system level. Comptroller and Auditor General of India revealed in their report (2014 and 2015) these high end equipment and other medical devices are not being managed economically, efficiently or effectively across the country. For optimal utilization of the equipment a comprehensive plan is required at the central, state and individual hospital levels.

Mutia et al., (2012), and Yaryha (2016) have emphasized the health care manager should ensure the equipments used in medical care are operational, safe, properly configured and efficient to meet the mission of the government and hospital.

Utilization index or Use-Coefficient (Gupta and Kant 2000) is one of important metrics to assess the functional status, availability, and productivity of an equipment or a service.

$$\text{Use-Coefficient} = N/M \times 100$$

where N is average number of hours the equipment used per day.

M is average number of hours the equipment can be used per day.

Kumar (2014) and Gupta et al., (2017) have stated that Utilization index is one of the important parameters to review the productivity and optimal utilization of any equipment, which results effective usage, cost containment, quality care and patient satisfaction.

AIM &OBJECTIVES

The main aim was to study the utilization pattern of the capital-intensive MRI Scan equipment. The objectives followed are: 1. To estimate the work load of the MRI scanner. 2. To analyze the utilization hours and estimate use coefficient of MRI.

METHODS AND METHODOLOGY

The study was an observational and cross-sectional conducted over a

period of 6 months in a teaching hospital. We used two management tools semi structure interviews and equipment utilization analysis. The study was a cross-sectional for semi structured interviewing MRI technicians, doctors, and ministerial staff. The study protocol was approved by the institutional ethical committee. Based on the previous studies, we calculated work load of MRI scanner. Use coefficient was applied to assess the utilization of hospital equipment i.e., whether the equipment is optimally utilized or under used. If the use coefficient is more than 50 percent, it is considered to be well utilized.

RESULTS:

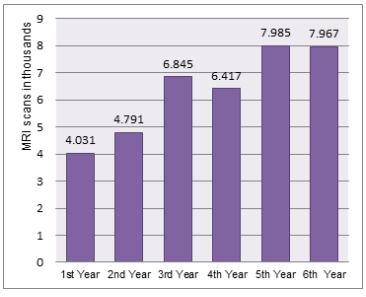
The work load of the MRI scan unit was carried out by studying the records and registers and observing the work flow. The data was collected and analyzed. The total number of cases were 38036 in six year, it is shown in Table.1 and Fig. 1.

Time for a scan: The time for total MRI scans calculated over a period of one month for each type of scan. 60cases of brain scans, 65 cases of spine scans and others 1to 5 cases were observed and time

Table 1. The total number of cases in six years

Year	No. of cases	% of change relative to previous year
1st year	4031	
2nd year	4791	18.86
3rd year	6845	42.87
4th year	6417	-6.25
5th year	7985	24.435
Study year	7967	-0.23
Total	38036	Average: 6339/ year

Fig.1 Number of MRI scans in Six years



was recorded. The average time for each type scan was estimated from the data recorded excluding the turnaround time, is shown in Table.2 and Fig. 2.

Out of 691 MRI scans which were taken during the month, Brain plain and contrast both was 32.127 % (222), Cervical Spine was 15.484 % (107), Dorso Lumbar Spine and Thoraco Lumbar spine were 8.39% (58), Lumbo Sacral spine was 20.40 % (141), MRA was 14.03 % (97), MRV was 3.76% (26) and other types of scans were about 5.788% (40). The total time taken for 691 MRI scans was 15460 minutes and 47 seconds, it is shown in the Table 2, excluding the turnaround time between each procedure for shifting patients to and from MRI scanner, the position and adjusting coils for different anatomical parts was nearly 5 to 10 minutes on average 8 minutes. There were 30 working days in the month of study excluding one annual maintenance day. MRI scan unit functioned from 8.00 am to 10.00 pm every day, i.e., 14 hours per day. The total scanning time for the month was 15460 minutes 47 sec. The turnaround time was estimated by observation and it was 8 minutes on average and calculated for 691 scans it was 5528 minutes, it is shown in the Table.3

Table 2. The average time of each type of MRI scan

S.No	Part of body	No. of scans	Total time	Average time
1	Lumbosacral Spine	141	2919.54	20.34
2	Brain Plain	131	2489	19
3	Cervical Spine	107	1747.4	16.2
4	Magnetic Resonance Angiogram	97	1985.16	20.28
5	Brain plain & Contrast	91	3094	34
6	Thoracic Lumbar Spine & Dorsal Spine	58	1406.3	24.15
7	M.R. Venogram	26	507	19.3
8	Knee Joint	12	420.48	35.04
9	M.R. Spectroscopy	4	130	32.3
10	Lower Limb	3	100	33.2
11	Neck MRA	2	60.32	30.16
12	Hip	2	77	38.3
13	Thigh	2	54.3	27.15
14	Steoreotactic Biopsy	2	48	24
15	Deep Brain Stimulation Thalamic	2	72	36
16	M.R. Cholongio- pancreato graphy	1	19.18	19.18
17	Shoulder	1	41.25	41.25
18	Pelvis	1	15.3	15.3
19	Endorectal MRI	1	22.24	22.24
20	Breast	1	34	34
21	Chest	0	0	0
22	Upper Limb	0	0	0
23	Others	6	216	36
		691	15460.47	22.58

Fig.2.Analysis of time taken for each type of MRI scan procedures.

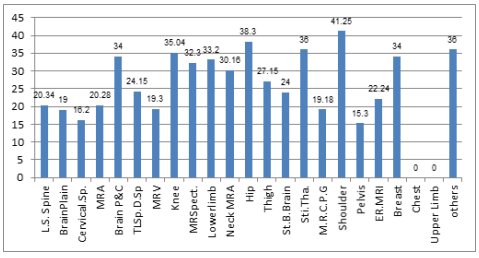


Table.3. The total time for MRI scanning procedure in the month

Total scan time in the month	15460 min.47 sec
Turnaround time average 8 minutes 8 x 691 scans (Working day = 14 hours per day)	5528 min
Total	20988 min. 45 sec

$$\text{Time taken per scan} = \frac{\text{Total time of scanning including turnaround time in the month}}{\text{Number of scan in the month}}$$

$$= \frac{20988 \text{ minutes } 47 \text{ sec.}}{691} = 30 \text{ min.} 58 \text{ sec.}$$

An average 23 scans were taken each day. An average each procedure took 30 minutes 58 seconds.

Use Coefficient of MRI Scanner: According to Gupta S, Kant S (2000) use coefficient is applied to access the utilization of equipment i.e., whether the equipment is optimally utilized or under- utilized. The use coefficient of MRI was calculated by the following formula:

$$\text{Use coefficient} = \frac{N}{M} \times 100$$

The total taken for MRI scanning in July 2005 = 20988min.47sec.
The average number of hours the MRI scanner operated in the month:

$$= \frac{20988\text{min.}47\text{sec}}{30 \text{ days}} = 699 \text{ min.} 37\text{sec.} = 11 \text{ hrs.} 39 \text{ min.}$$

Maximum number of hours the equipment can be used per day = 24 hours.

$$\text{Use coefficient of MRI scanner} = \frac{11\text{hrs.}39 \text{ min.}}{24\text{hrs}} \times 100 = 48.54\ \%$$

DISCUSSION

The hospital efficiency depends upon the effective utilization of diagnostic facilities. The utility of diagnostic equipment is an important parameter to know the effectiveness of cost center.**[15]** This study conducted in the Nizam's Institute of Medical Sciences. The Use

coefficient of MRI was 48.54%. To increase the UC of MRI the institute may tie up with nearby local hospitals.

Zimmer (2018) stated that, MRI services have seen a steady increase in usage, with increased demand on it, operational details like staff and patient scheduling, service turn-around-times, and throughput have become more challenging. In their study they observed that service time range: 24 minutes to 160 minutes and an average was 58 minutes and total number patients inpatients 4895 out patients 2922 in one year. The utilization percentage 70% range (MRI facility 1-73.88%; MRI 2-70.22%; MRI 3- 78.49%). The statistical report by Radiology Business Management Association (2009) has emphasized that Availability-based utilization rate for advanced imaging services range from 61% to 75%. In their study they stated, the average-turn-round time from 105 work time observations was 26 minutes and 46 seconds with standard deviation of 20minutes and 47 seconds. The average process time was 10 minutes, 14 seconds, and the non-value added was 16 minutes and 32 seconds. The process time was 38% and non-value added time was 62%. In our study the process time average was 22 minutes and 58 seconds and shifting time was 8 minutes. The process time 74.16% and the non value added time was 25.84%.

CONCLUSION

The present study contributes to our knowledge in the area of utilization rates or use coefficient of high end diagnostic modalities. Similar studies are required where the Use Coefficient of equipment and devices are estimated in the field of hospital management. The Comptroller and Auditor General of India (2015) report revealed that most of the equipments are underutilized in many hospitals. So the statutory bodies and governing bodies need to mention certain specific protocols to enhance the utilization rate of high end equipment in the public hospital. The public authorities should prepare more policies to increase the utilization rates of high end diagnostic equipment in hospitals, so that health care managers will perform better rather blaming the systems failures.

Limitations of study

In this study, the main limitation was estimating the non value added time. The larger sample work time analysis could have been helpful to this study.

Competing Interest: None

Financial Assistant: None

Ethical Considerations: Ethical issues (including consent, misconduct, data fabrication and /or falsification, double publication and/or submission, redundancy , plagiarism, etc.) have been completely observed by the author.

Acknowledgment: This work is dedicated to late C.Gopal Chari (1946- 2016), retired deputy commercial tax officer, who inspired me and made me love doctor's profession through his high standards of life, commitment, and exemplary brilliance. I am greatly indebted to Dr. G. Vijay Kumar, my preceptor, who guided me. I am grateful to the Department of Hospital Administration of Nizams Institute of Medical Sciences. I am grateful to Prof.Kakarla Subba Rao.

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