

Utilisation of the Equipments in the Department of Radiology and Imaging Services in a Tertiary Care Centre –A Retrospective Study

Padmini Kumari B^{1*}, G Vijay Kumar² and K. Ravi Babu²

- 1 Senior resident, Department of Hospital Administration, Kasturba Medical College, Manipal, Karnataka, India.
- 2 Department of Hospital Administration, Vydehi Institute of Medical Sciences and Research Centre (VIMS & RC), Bengaluru, India

Abstract

Purpose of study: To study the equipment utilisation in the department of Radiology and imaging services.

Methods: We performed retrospective evaluation of the data obtained on basis of past records maintained in the department of Radiology and imaging services from January 2015 to December 2016. The data regarding the CT, MRI, X-ray and Ultra sonography were collected using well-structured proforma for statistical evaluation.

Results: When compared to 2015, in 2016 there was increase in utilisation of all imaging services, X- ray by 32.02%, USG by 13.98%, CT by 12.55% and MRI by 10.27%. Maximum utilisation of all imaging services was from outpatient department in both 2015 and 2016 with ultrasonography mainly utilized by females.

Conclusions: In our study it was found that the department of Radiology and imaging services was fairly utilised as per the standard guidelines in spite of some limitations. There was periodic auditing of the equipments and their utilisation by the administration which helps in appropriate utilisation of services. Increased utilisation of imaging services observed in our study adds to the healthcare costs of the public and it also shows affordability of people which may also be considered in developing country like India.

Keywords: Equipments; Imaging services; Utilisation; Guidelines; Healthcare

*Corresponding author:

Padmini Kumari B

✉ drpadminisree@gmail.com

Tel: +919449182243

Senior resident, Department of Hospital Administration, Kasturba Medical College, Manipal, Karnataka, India.

Citation: Padmini Kumari B, G Vijay Kumar, K. Ravi Babu (2021) Utilisation of the Equipments in the Department of Radiology and Imaging Services in a Tertiary Care Centre –A Retrospective Study. J Hosp Med Manage Vol.7 No.4:270.

Received: April 23, 2021, **Accepted:** April 26, 2021, **Published:** May 10, 2021

Introduction

It is essential to ensure maximum utilisation of the equipment with minimum downtime. Radiology and imaging services is central to the clinical practice of medicine across a wide range of disciplines. As a consequence of the increasing sophistication and accuracy of clinical imaging, the utilization and importance of these imaging modalities have increased dramatically and consistently over the last 20 years [1,2].

Apart from providing routine and specialized diagnostic services with various imaging techniques for indoor, out-patients and walk-in patients, the modern departments also provides therapeutic services like interventional radiology (minimally invasive treatments performed with imaging guidance). This acts

as a big source of revenue generation for a hospital or a stand – alone centre with high profitability. One out of every 4-5 patients utilise this service in one form or other and quality of services provided by this department have a direct impact on the level of treatment provided to the patient by the hospital [3].

Diagnostic radiology is a major growth industry in the healthcare sector worldwide [4].

Without doubt, radiological technology has revolutionized the practice of medicine [5]. To manage such large number of sophisticated and expensive machines whose rays/emissions are hazardous to healthcare calls for a critical planning taking in to consideration the safety aspect of patient, public and the department staff.

Radiology department generally has diagnostic as well as therapeutic sections. The major components of radiology/imaging services are: Radiography (X-ray machines), Mammography, Dual-energy X-ray absorptiometry (DEXA), Computed tomography (CT scan), Ultrasound and Color Doppler, Magnetic Resonance Imaging (MRI), Digital Subtraction angiography (DSA), Nuclear Imaging Systems.

The purpose of this study is to assess the utilisation of the various imaging services at our Hospital and compare it with recommended standards and also to identify key areas for improvement.

Materials and Methods

This retrospective study was done on basis of past records maintained in the department of Radiology and imaging services from January 2015 to December 2016. The statistical data is collected from Jan 2015-Dec 2016 to evaluate the utilisation of the radiology and imaging services of Vydehi Institute of Medical Sciences and Research Centre (VIMS & RC), Bengaluru. Due consent was taken from the Heads of Department of Radiology and imaging services and also Medical records department, VIMS & RC for collecting data.

The data regarding the CT, MRI, X-ray and Ultra sonography were obtained for our study. The data was collected using well-structured proforma as required for the study in terms of age, sex and different departments utilized in our institute.

All the cases registered in VIMS & RC Radiology Register book from 01.01.2015 to 01.12.2015 & 01.01.2016 to 31.12.2016 have been included in the study and Cases which we can't read because of improper hand writing have been excluded.

The data collected was analyzed statistically using Microsoft excel software 2010 data sheets and expressed using descriptive statistics like Mean, Percentages. Limitations of the study is only four investigation modalities were included in the study (X-ray, USG, CT, and MRI).

Results

Vydehi Institute of Medical Sciences and Research Centre (VIMS & RC) is a 1200 bedded multispecialty tertiary care center. It has General Hospital, Super Specialty, Critical care and Special rooms. The radiology and imaging services of Vydehi Medical College Hospital was established in the year 2002, and was approved by AERB (ATOMIC ENERGY REGULATORY BOARD) in the year 2007. We included data regarding the CT, MRI, X-ray and Ultra sonography in our study. The department is headed by qualified experienced radiologist (HOD). The HOD is assisted by 3 professors, 2 associate professors, 4 assistant professors, 3 senior residents and 30 junior residents. There is total 6 nursing staff including sister in charge and 6 receptionists. There are 14 radiographers including chiefradiographer.

Total number of patient's utilized radiological services in the year 2015 was 291609. Out of which the maximum 10.06% (29335) were being utilised in the month of December 2015. The minimum number of patients who utilized radiological services were 17360 (5.95%) in the month of April 2015 (**Table 1**).

Table 1: Utilisation of Services [Monthwise] – 2015.

2015 Month	CT Scan	MRI	X-Ray	USG	TOTAL n (%)
Jan	952	200	13571	4908	19631 [6.73]
Feb	966	250	12172	5391	18779 [6.44]
Mar	1155	286	14178	6706	22325 [6.76]
Apr	894	277	11200	4989	17360 [5.95]
May	951	281	12450	5521	19203 [6.59]
June	996	271	16343	6708	24318 [8.34]
July	1128	291	20217	7345	28981 [9.94]
Aug	1040	248	20264	7241	28793 [9.87]
Sep	1084	324	19069	6890	27367 [9.38]
Oct	1090	260	19142	7055	27547 [9.45]
Nov	1319	273	19693	6685	27970 [9.59]
Dec	1407	252	20505	7171	29335 [10.06]
Total (%)	12982 (4.45%)	3213 (1.10)	198804 (68.17)	76610 (26.27)	291609

Total number of patient's utilized radiological services in the year 2016 was 367930. Out of which the maximum 8.78% (32300) were being utilized in the month of July 2016. The minimum number of patients who utilized radiological services was 7.89% in the months of February and November 2016

In 2015, of total 198804 X-ray investigation, maximum were used by the age group 21-40 Yrs (49.75%), followed by 41-60 Yrs (29.64%), 0-20 yrs (11.96%), 61-80 yrs (8.19%) and least utilised by the age group 81-100 (0.46%) (**Table 2**).

Of total 12982 CT investigation, maximum were used by the age group 21-40 yrs (49.93%) followed by 41-60 yrs (28.62%) and age group 61-80 and 0-20 yrs utilised the same amount of services (10%) and least by the age group 81-100 yr (0.36%).

Of total 3213 MRI investigation, maximum were utilisation by the age group 21-40 yrs (46.28%), followed by 41-60 yrs (37.04%), 61-80 yrs (8.9%), 0-20 yrs (7.63%) and least utilised by the age group 81-100.

Of total 76610 USG investigations, maximum were utilised by the age group 21-40 yrs (65%) followed by 41-60 yrs (24.51%) then by 0-20 yrs (5.23%), 61-80 yrs (4.86%) and least by the age group 81-100 (0.3%) (**Table 3**).

In 2016, of total 262458 X-ray investigation, maximum were used by the age group 21-40 Yrs (47.26%), followed by 41-60 Yrs (30.93%), 0-20 yrs (12.8%), 61-80 yrs (8.6%) and least utilised by the age group 81-100 (0.41%).

Of total 14611 CT investigation, maximum were used by the age group 21-40 yrs (53.47%) followed by 41-60 yrs (26.33%) and age group 61-80 and 0-20 yrs utilised the same amount of services (10%) and least by the age group 81-100 yr (0.36%).

Of total 3543 MRI investigation, maximum were utilisation by the age group 21-40 yrs (45.3%), followed by 41-60 yrs (36.92%), 61-80 yrs (9.14%), 0-20 yrs (8.5%) and least utilised by the age group 81-100 (0.14%).

Of total 87318 USG investigations, maximum were utilised by the age group 21-40 yrs (62.16%) followed by 41-60 yrs (26.83%) then by 0-20 yrs (5.61%), 61-80 yrs (5.6%) and least by the age

Table 2: Utilisation Of Services [Month Wise] – 2016.

2016	CT Scan	MRI	X-Ray	USG	TOTAL n (%)
Month	CT Scan	MRI	X-Ray	USG	TOTAL n (%)
Jan	1772	232	20922	7535	30461 [8.28]
Feb	1228	183	20903	6722	29036 [7.89]
Mar	1207	277	22499	7619	31602 [8.59]
Apr	1274	311	21391	7147	30123 [8.19]
May	1315	301	22453	7549	31618 [8.59]
June	1287	335	22843	7409	31874 [8.66]
July	1197	336	23177	7590	32300 [8.78]
Aug	1087	344	22300	7378	31109 [8.46]
Sep	1110	351	22266	7370	31097 [8.45]
Oct	970	320	21455	6821	29566 [8.04]
Nov	1090	270	20771	6915	29046 [7.89]
Dec	1074	283	21478	7263	30098 [8.18]
Total (%)	14611 (3.97)	3543 (0.96)	262458 (71.32)	87318 (23.73)	367930

Table 3: Utilisation Based On Age-2015.

2015	0-20	21-40	41-60	61-80	81-100	TOTAL
MRI	245(7.63%)	1487(46.28%)	1190 (37.04%)	286 (8.9%)	5 (0.16%)	3213
CT	1401(10.8%)	6482(49.93%)	3716 (28.62%)	1336 (10.3%)	47 (0.36%)	12982
USG	4083(5.33%)	49796(65%)	18774 (24.51%)	3727(4.86%)	230(0.3%)	76610
X-R AY	23777(11.96%)	98905 (49.75%)	58926 (29.64%)	16282(8.19%)	914(0.46%)	198804

Table 4: Utilisation Based On Age-2016.

2016	0-20	21-40	41-60	61-80	81-100	TOTAL
MRI	301(8.5%)	1605(45.3%)	1308(36.92%)	324(9.14%)	5(0.14%)	3543(100%)
CT	1471(10.07%)	7813(53.47%)	3847(26.33%)	1428(9.77%)	52(0.36%)	14611(100%)
USG	4453(5.1%)	54278(62.16%)	23427(26.83%)	4898(5.61%)	262(0.3%)	87318(100%)
X- RAY	33595(12.8%)	124037(47.26%)	81178(30.93%)	22571(8.6%)	1077(0.41%)	262458(100%)

group 81-100 (0.3%)(Table 4).

Males have utilised more radiological services (54.62%) overall compared to females (45.38%) in the year 2015. But USG utilisation was found to be more in females (63.25%) whereas male utilisation of USG was less (only 36.75%) (Table 5).

Males have utilised more radiological services (58.37%) overall compared to females (41.63%) in the year 2016. But USG utilisation was found to be more in females (65.37%)(Table 6).

Diagnostic imaging services was utilised more by outpatient department(OPD) (80.98%) in the year 2015 and the minimum number of patients who utilized diagnostic imaging services were emergency department patients (3.13%) in the same year. From OPD maximum utilization was by USG (91.04%) and the minimum utilization was by MRI (68.04%) (Table 7).

Diagnostic imaging services was utilised more by outpatient department (79.09%) in the year 2016 and the minimum number of patients who utilised diagnostic imaging services were emergency department patients (2.86%) in the same year. From OPD maximum utilisation was by USG (90.92%) and the minimum utilization was by MRI (70.93%) (Table 8).

When compared to 2015, in 2016 there was increase in utilisation of all imaging services, X- ray by 32.02%, USG by 13.98%, CT by 12.55% and MRI by 10.27% (Table 9).

Table 5: Utilisation Based On Gender-2015.

Service	Male n(%)	Female n(%)	Total n(%)
MRI	2382 (74.14)	831 (25.86)	3213
CT	8074 (62.19)	4908(37.81)	12982
USG	28157 (36.75)	48453 (63.25)	76610
X-RAY	120684 (60.71)	78120 (39.29)	198804
Total n (%)	159307 (54.62)	132333 (45.38)	291640 (100.0)

Table 6: Utilisation Based On Gender-2016.

Service	Male n (%)	Female n(%)	Total n(%)
MRI	2034 (57.41)	1509 (42.59)	3543
CT	9957 (68.15)	4654 (31.85)	14611
USG	30237 (36.63)	57081(65.37)	87318
X-RAY	172543 (65.74)	89915 (34.26)	262458
Total n (%)	214771(58.37)	153159(41.63)	367930(100.0)

Table 7: Utilisation Based On Department -2015.

Services	OPD	IP	EMD	TOTAL
MRI	2186 (68.04)	962 (29.94)	65 (2.02)	3213
CT	9208(70.93)	2777(21.39)	997(7.68)	12982
USG	69743 (91.04)	5617 (7.33)	1250 (1.63)	76610
XRAY	154479 (77.71)	37519 (18.87)	6806 (3.42)	198804
TOTAL	235616 (80.98)	46875 (16.07)	9118 (3.13)	291609

Table 8: Utilisation Based On Department -2016.

Services	Outpatient Department (Opd)	In Patient Department (Ipd)	Emergency Medical Department (Emd)	Total
MRI	2513 (70.93)	973 (27.46)	57 (1.61)	3543
CT	10662 (72.97)	3335 (22.83)	614 (4.20)	14611
USG	79392 (90.92)	6438 (7.37)	1488 (1.71)	87318
XRAY	198455 (75.61)	55652(21.20)	8351(3.19)	262458
TOTAL	291022 (79.09)	66398(18.05)	10510 (2.86)	367930 (100.0)

Table 9: Comparison of Utilisation of Services-2015 & 2016.

Services	2015	2016	Increase in percentage in 2016	Total
MRI	3213	3543	10.27	3543
CT	12982	14611	12.55	14611
USG	76610	87318	14	87318
XRAY	198804	262458	32.02	262458
TOTAL	291640	367987	26.18	367930 (100.0)

Discussion

Imaging services takes away a large share of total capital investment and is also perhaps the highest single revenue earner among all the services. Quality of services provided by the department of radio diagnosis, therefore, is of utmost importance for the overall quality of patient care in the hospital [3]. With the adaptation of proper maintenance techniques and management systems one can utilize resources optimally and reduce the breakdown and related maintenance workload [4]. It should be an earnest endeavour of the management and users to optimize the equipment utilization to obtain maximum return on capital invested. In an era of cost-intensive medical care, every equipment being installed in healthcare institutions need to be fully and properly utilised.

An optimum utilization of equipment will result in optimal patient handling and rapid turnover, minimum possible cost, quality patient care and satisfaction. Efficient equipment utilization should be ensured to optimize healthcare facilities. A substantial number of equipments in Indian healthcare institutions are of foreign origin. It is imperative that appropriate steps are taken in the planning, procurement installation, and usage stages of these equipment to maximize utilisation and optimize healthcare facilities.

According to data available from radiology and imaging department of VIMS & RC, total 291640 and 367930 radiology examinations were done in 2015 & 2016 respectively. It was observed that are more male respondents in comparison to their female counterparts in all modalities except USG services. It seemed to be because of more male patients coming to hospital. It was observed that obstetrics and gynecology patients use more USG services.

In this study X-rays was the commonest one, followed by USG

and least by MRI. It seemed X-rays are commonly requested investigation from all departments and among these extremities X-ray was the commonest one. Chest X-ray was the second commonest followed by Spine-X ray, Skull X-ray and abdominal X-ray. Spanish study [6] by Delgado Nicolás and PecesMorate (1996) analyzed the quality of requests in primary health care for radiological investigation and results showed bone (41.87%) and thorax (25.12%) radiological examinations were the commonly requested examinations and of all 203 radiological examinations pathology was found in 67.98%.

A study, published in Spanish, on radiology demand in primary healthcare was carried out at Public Health Care Center Poblenu, in Barcelona found out that pathology was found in 43% of the examinations in that study. The reasons behind that why male have more extremities X-ray and female have more Chest X-ray utilization might be due to trauma cases among male population to take Extremities X-ray and Routine Medical Examination for job application among female population has taken more Chest X-ray [4].

In a study by Andrea J et al [7] a 3.8% increase in the rate of Noninvasive diagnostic investigations utilization occurred during the 6-year period between 1993 and 1999. The utilization rate for conventional radiography decreased 13.7%, while that of all other modalities increased a combined total of 39.1%. In another study by MythreyiBhargavan et al [8] utilization of high-technology modalities increased rapidly, while that of radiography was relatively stagnant. Variation in utilization among states and census regions was substantial. But in our study in 2016, when compared to 2015, X-rays were used 32%, CTs were used 12%, and USG were used 14% and MRI were used 10% more. It was because of more patients visited our hospital during the year 2016 may be due to more population morbidities. In a study from Serbia [9] the total cost of services increased because of a rise in overall consumption and population morbidity. Laurence Parker et al in their study [10] showed is substantial regional variation in utilization of noninvasive diagnostic investigations.

It was observed that, the overall collection from radiology and imaging services were increased in the year 2016. The staffs working in the department was utilized to optimum resulting in increased revenue for the department without staff being increased but at the same time increasing the health care costs to the public.

In our study we found that the department of Radiology has all necessary equipments approved by AERB safety guidelines. A defined policy on equipment maintenance & a planned preventive maintenance was practiced in the department. A Biomedical Engineer and Radiation Safety Officer were available round the clock for the common problems that can be managed at the department level.

The department had written instructions and copy of operating manual for handling various equipments in the department and the staffs were trained regularly regarding any updates by the company persons. Only two Radiographers and nurse in charge are allowed to enter and perform MRI examinations. In their absence MRI appointments will be delayed.

A Case Study of a Zimbabwean Hospital by G R Chingarande et al [11] concluded that all equipment should be adequately cleaned as they are at risk of becoming vectors for microorganisms that cause nosocomial infections. For this study pieces of equipment used during an examination that were of particular risk were the lead apron, the horizontal Bucky and handle, the cassette, the X-ray tube handle, the viewing box, the X-ray control panel, the chin rest, the probe lens, the erect Bucky, the hopper handle, the hatch handle and the darkroom work surface. There was a lacuna in periodic sterilization of equipments with defined infection control policy even though hospital infection control management exists.

Minor breakdown of equipments were taken care by biomedical engineer of the hospital and it was rectified within hours not more than 10 to 12 hours. Any power related issues was taken care by electrician. Major breakdown which was not able to rectify by the biomedical engineer was referred to company. In that case the equipments got repaired by more than 24 hours to 2-3 days. Major equipment breakdown for major equipments was once in 3-4 months after continuous use in the work period. But it was not significant amount of time. The department has all necessary equipments as per the standards, but machines are not enough to cover all patients during normal working hours especially when there is breakdown of equipments.

Recalibration of equipments was done once in a year by authorized persons registered under BARC [Baba atomic research centre]. PPE [personnel protective equipments] like lead aprons, gloves, thyroid and gonadal shields were tested periodically once in a year by biomedical engineer for their efficiency. The department was fairly equipped as per AERB guidelines and also periodic auditing of the equipments and their utilisation by the administration.

In our study, with proper preventive maintenance protocol there was no major breakdown (down time) of equipment during 2015 and 2016, which might have resulted in increased revenue output.

Proper utilisation also avoids unnecessary expenditure, which may be needed for periodic maintenance of equipments. Appropriate utilisation of manpower and equipment reduces

staff demotivation and indirectly prevent staff leaving the organisation. In our study we found that manpower and equipment are appropriately utilized without staff being increased. The department has defined policy of planned preventive maintenance contract with the service provider, and a biomedical engineer is available round the clock for the common problems that can be managed at the unit level.

The department has written instructions and copy of operating manual for handling various equipments in the department and the staffs were trained regularly. As there is always scope for improvement, department of radiology and imaging services needs to adopt some of the standard recommended guidelines to fulfill the needs of the patients in providing increased quality health care and also to further increase in revenue from the department.

Conclusion

In our study it was found that the department of Radiology and imaging services was fairly utilised as per the standard guidelines in spite of some limitations. The department has defined policy of planned preventive maintenance contract with the service provider during equipment breakdown. There was periodic auditing of the equipments and their utilisation by the administration. These policies add onto appropriate utilisation of equipments and imaging services. As the safety of patient and staff is most important there is more scope in having defined infection control policy in the department. Increased utilisation of imaging services observed in our study adds to the healthcare costs of the public and it also shows affordability of people which may also be considered in developing country like India. At the same time increased morbidity of the people due to diseases seeking healthcare cannot be ruled out and needs further evaluation.

Acknowledgements

We acknowledge the great help provided by Dr Sreenivas T in writing this manuscript.

Conflict of Interest/Funding

None.

References

1. Wu CY, Hu HY, Chen L, Huang N, Chou YJ (2013) Investigating the utilization of radiological services by physician patients: a population-based cohort study in Taiwan. *BMC Health Serv Res* 13:284.
2. Black WC, Jadad AR, Jarvik JG, Kazerooni EA, Langlotz CP, et al. (2001) Evidence-based Radiology: A New Approach to the Practice of Radiology. *Radiology* 220:566-575.
3. Joshi SK (2014) Quality management in hospitals. 2nd edition. New Delhi: Jaypee.
4. SanThitsa Aung, SanSanOo, M.Kamil, Zay Soe, Zaw Aung, et al. (2013) Utilization of Radiology Service at Dungun District Hospital in Malaysia. *Int J Collab Res Intern Med Public Health* 5:279-294.
5. Amis ES, Butler PF, Applegate KE (2007) American College of Radiology white paper on radiation dose in medicine. *J Am Coll Radiol* 4:272-284.
6. Delgado Nicolás MA, PecesMorate FJ, Aten Primaria (1996) Analysis of the use of radiology in primary health care 17:52-56.
7. Andrea J Maitino, David C Levin, Laurence Parker, Vijay M Rao, Jonathan H Sunshine (2003) Health Policy and Practice. Nationwide Trends in Rates of Utilization of Noninvasive Diagnostic Imaging among the Medicare Population between 1993 and 1999. *Radiology* 227.
8. Mythreyi Bhargavan, Jonathan H Sunshine (2005) Utilization of Radiology Services in the United States: Levels and Trends in Modalities, Regions, and Populations. *Radiology* 234.
9. Mihajlo Jakovljević, Ana Ranković, Nemanja Rančić, Mirjana Jovanović, et al. (2013) Radiology Services Costs and Utilization Patterns Estimates in Southeastern Europe—A Retrospective Analysis from Serbia. *Value in Health Regional Issues* 2:218-225.
10. Laurence Parker, David C Levin, Andrea Frangos and Vijay M Rao (2010)

Geographic Variation in the Utilization of Noninvasive Diagnostic Imaging: National Medicare Data, 1998–2007. *Am J Roentgenology* 194: 1034-1039.

11. Chingarande GR, Chidakwa L (2013) Infection Control in A Resource Constrained Radiology Department: A Case Study of a Zimbabwean Hopital. *The Internet J Radilol* 16.