

Utilization Study of Various Modalities in Radiology Department, Shalby Hospital

By

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*Dissertation submitted for the partial fulfillment of the
MBA Hospital and Health Management*

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TO WHOMSOEVER MAY CONCERN

This is to certify that Ms. Eshna Srigyan, student of MBA Hospital and Health Management from IIHMR University, Jaipur has undergone dissertation/internship training at Shalby hospital, Ahmedabad, from 1st February, 2016 to 30th April, 2016.

The Candidate has successfully carried out the study designated to her during the dissertation/internship training and her approach to the study has been sincere, scientific and analytical.

The dissertation/internship is in fulfilment of the course requirements.

I wish her all success in all her future endeavours.



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TO WHOM IT MAY CONCERN

This is to certify that Ms. Eshna Srigrayan student of **MBA - Hospital Management** from **Indian Institute of Health Management Research, Jaipur** has completed her dissertation from 1st February, 2016 to 30th April, 2016 at Shalby Hospital, Ahmedabad.

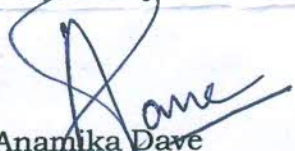
She has completed her dissertation on **Utilization study of various modalities in Radiology department.**

She has also participated and coordinated NABH re-accreditation showcasing various Clinical and Managerial Indicators and the method of their monitoring.

During the period of her association with us, she has endeavored to conceptualize theory into practice in various hospital activities.

She was found to be honest, diligent, sincere and hardworking during her association with us.

For, Shalby Ltd.


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Senior Manager - HR

THE IIHMR UNIVERSITY, JAIPUR

CERTIFICATE BY SCHOLAR

This is to certify that the dissertation titled Utilization study of
..... various modalities in Radiology Department,
..... Shalby Hospital and submitted by (Name) Eshna
..... Smigyan Enrollment No. 1549 under
the supervision of Ms. Nutan P. Jain for award
of Postgraduate Diploma in Hospital and Health/ Pharmaceutical / Rural Management of
the University carried out during the period from 1st February, 16 to
..... 30th April, 16 embodies my original work and has not formed the basis for the
award of any degree, diploma associate ship, fellowship, titles in this or any other Institute
or other similar institution of higher learning.


Signature

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I genuinely thank my parents, family and friends for their blessings and support. Last but not the least I am thankful to God, for getting an opportunity to learn from this organization

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LIST OF ABBREVIATIONS

MRI	Magnetic Resonance Imaging
USG	Ultrasonography
CT	Computed Tomography
OP	Out-patient
IP	In-patient
HIS	Hospital Information System

INTRODUCTION

Modern medical technology has contributed immensely in improving the quality of healthcare and the state of health profile of nations. The introduction of state of the art technology has resulted in metamorphic changes in diagnostic and therapeutic modalities in patient care activities. This has led to the enhancement of quality of life and decreased mortality and morbidity rates.

Medical imaging modalities of investigation have assumed great significance in the past two decades. While this increased availability of advanced imaging has been associated with improved patient outcomes for some diseases, there are growing concerns about the possibility of inappropriate utilization of imaging because of its potential contribution to both patient harm and rising health care costs.

In today's healthcare environment, the equipment purchase must be cost justified as India being a developing country has constrained resources. Establishment and maintenance of Radiology equipments in a hospital is expensive and every effort must be made for optimum utilization of this equipment in appropriate manner.

The utilisation study conducted in the Radiology Department, Shalby Hospital, Ahmedabad was for four modalities :-

1. X-Ray
2. MRI
3. CT
4. USG

X-Ray Machine:-

X-ray imaging is a transmission-based technique in which X-rays from a source pass through the patient and are detected either by film or an ionization chamber on the opposite side of the body.

The heart of an X-ray generator is the X-tube. Like any vacuum tube, the X-ray tube contains a cathode, which directs a stream of electrons into a vacuum, and an anode, which collects the electrons and is made of copper to evacuate the heat generated by the collision. When the electrons collide with the target, about 1% of the resulting energy is emitted as X-rays, with the remaining 99% released as heat. Due to the high energy of the electrons that reach relativistic speeds the target is usually made of tungsten even if other materials can be used particularly in XRF applications.

A cooling system is necessary to cool the anode; many X-ray generators use water or oil recirculating systems.

There are 3 main X-ray machines and 2 portable X-ray machines which is placed in Shalby hospital with following specification:-

1. X-ray 1
 - Company Name – Siemens
 - Model Name – Polydoras

- Year of Installation – April, 2007
- 2. X-ray 2
 - Company Name – Siemens
 - Model Name – Polydoros
 - Year of Installation – January, 2008
- 3. X-ray 3
 - Company Name – Siemens
 - Model Name – Polydoros
 - Year of Installation – October, 2013
- 4. Portable X-ray 1
 - Company Name – Siemens
 - Model Name – MM 2.5
 - Year of Installation – December, 2008
- 5. Portable X-ray 2
 - Company Name – Siemens
 - Model Name – MM 2.5
 - Year of Installation – April, 2010

Magnetic Resonance Imaging (MRI) :-

Magnetic resonance imaging (MRI) is a non-ionizing technique with full three dimensional capabilities, excellent soft-tissue contrast, and high spatial resolution. It is a medical imaging technique used in radiology to investigate the anatomy and physiology of the body in diseases.

The MRI signal arises from protons in the body, primarily water, but also lipid. The patient is placed inside a strong magnet, which produces a static magnetic field typically more than 104 times stronger than the earth's magnetic field. Each proton, being a charged particle with angular momentum, can be considered as acting as a small magnet. The protons align in two configurations, with their internal magnetic fields aligned either parallel or anti-parallel to the direction of the large static magnetic field. The protons process around the direction of the static magnetic field. The frequency of precession is proportional to the strength of the static magnetic field.

MRI scan machine which is placed in Shalby hospital has the following specification:-

- Company Name – Siemens
- Model Name – M. Essenza
- Field Strength – 1.5 tesla
- Year of Installation – April, 2013

Computed Tomography (CT) :-

CT scan machine is used to assess the body part's structure or shape so as to investigate the diagnosis diseases or injuries. CT scan uses the X-rays and computer technology to create the rapid cross-section images of the body.

It consists of an X-ray tube that rotates around patient's body. Patient will usually be moved continuously through this rotating beam. The X-rays will be received by a detector on the opposite side of the body and an image of scan will be produced by a computer. The image produced by CT scans in the form of slices through the body are called tomograms or tomographic image.

The CT scan machine which is placed in Shalby hospital has the following specification:-

- Company Name – Siemens
- Model Name – Somatom Definition
- Total no. of slices – 128 slices
- Year of Installation – November, 2011

Ultrasonography (USG) :-

Diagnostic sonography is an ultrasound-based diagnostic imaging technique which is used for visualizing internal body structures including tendons, muscles, joints, vessels and internal organs for possible pathology and lesions.

In physics, the term “ultrasound” applies to all acoustic energy with a frequency above human hearing (20,000hertz or 20 kilohertz). For sonography, a hand held probe (transducers) is placed directly on and moved over the patient. A water based gel is used to couple the ultrasound between the transducer and patient.

In order to generate a 2 D-image, the ultrasonic beam is swept. A transducer may be swept mechanically by rotating or swinging. The received data is processed and used to construct the image. The image is then a 2D representation of the slice into the body. 3D images can be generated by acquiring a series of adjacent 2D images.

There are two USG machines which is placed in Shalby hospital with following specifications:-

1. USG 1

- Company Name – Siemens
- Model Name – HD6
- Year of Installation – May, 2007

2. USG 2

- Company Name – GE company
- Model Name – Logiq P5
- Year of Installation – May, 2008

REVIEW OF LITERATURE

According to Kumar N (2014) in his study on “Utilisation study of CT scan in a multi-speciality hospital”, the cost of imaging modalities is humungous in multi-specialty care hospitals. The administrators have to drive the management of plethora of investigative modalities with utmost care. As these are capital intensive, utilisation studies of such equipment after installation is very essential and drawn lot of significance since beginning. The introduction of CT has been one of the most significant advances among the imaging techniques. The first users were physicians within Research hospitals, then, community hospitals started using them and private practitioners, meanwhile, typically did not purchase the expensive systems. To study the utilisation of CT scan, the approach undertaken was a prospective study to find the number of scans done over a 6-month period, the average scans done in a day were calculated. The average time taken per scan was found. These calculations give the time the machine is being run over in a 8-hour shift. The 8-hour shift was considered as maximum time the machine is operable. The utilisation co-efficient index was the tool used to deduce the utilisation percentage of the CT scan. The machine in the study was utilised with 50% of its full potential.³

Geeta S (2004) in her study on “Medical equipments in government health facilities” explained that the availability and optimal utilization of medical equipment is important for improving the quality of health services. Significant investments are made for the purchase, maintenance and repair of medical equipment. Inadequate management of these equipments will result in financial losses and deprive the public of the intended benefits. A well-planned national policy on acquisition, utilization and maintenance of medical equipment needs to be established. The availability of adequate funds, technical knowledge, good leadership and healthy, cost conscious administrative practices will ensure a smooth flow of medical equipment along the various stages of the life cycle.

Aung S et al (2013) did their study on “Utilization of Radiology services at Dungun District Hospital in Malaysia” with the objective to explore the utilisation of radiology services at hospital. One year retrospective study was conducted which showed the high utilisation of radiological services in the hospital. However with relatively high workload the study also indicated the limited manpower and other facilities.¹

Chaudhary P et al (2015) in their study on “Factors affecting utilization of medical diagnostic equipment: a study at a tertiary healthcare setup of Chandigarh”, explained about the various factors responsible for influencing the utilisation of the diagnostic equipments. This study was conducted in a tertiary health care setup at Chandigarh. Approximately, 30 medical diagnostic equipments were studied for their Utilisation Coefficient and simultaneously a perception based analysis was conducted, where the faculty and staff members concerned with the administrative matters and use of that particular medical diagnostic equipment were interviewed. Factors such as low accessibility, obsolescence, break-down, affordability, availability of trained manpower, non-availability of consumables and spares, maintenance delays, limited working hours, and restricted availability were taken into account. The result however showed that on an average, 23% of the medical equipments were not adequately utilised and the factors influencing the utilisation as per the perception of the respondents were obsolescence, non-availability of spares and maintenance delays.⁵

According to Chaudhary P et al (2014) in their study on “An assessment of diagnostic equipment utilisation in a tertiary healthcare setup: a key to economical patient management”, explained the utilisation rate of various diagnostic modalities in comparison to their costing in terms of high cost, medium cost and low cost. The study was descriptive observational in nature and the data for the entire year of 2012 was collected by studying various records of department including purchase files, inventory registers, log books and service records of medical equipments. The results indicated that the utilisation coefficient of various diagnostic equipments were in the order of 58%, 62% and 60% for high cost, medium cost and low cost respectively. However, on an average, the utilisation coefficient of medical equipments was found to be 60% (above 50%), as the investment on an equipment is said to be good, if it shows the utilisation coefficient of 50% or above.⁴

Rao VM (2011) et al in their study on “Trends in utilisation rates of the various imaging modalities in emergency departments: nationwide Medicare data from 2000 to 2008”, stated that the rate of utilisation of various imaging modalities in emergency department is growing. The overall utilization rate per 1,000 beneficiaries for all imaging in EDs increased from 281.0 in 2000 to 450.4 in 2008 (+60%). The radiography utilization rate rose from 227.3 in 2000 to 294.3 in 2008 (+29%, 67 accrued new studies per 1,000). The CT rate rose from 40.0 in 2000 to 130.7 in 2008 (+227%, 90.7 accrued new studies per 1,000). The ultrasound rate rose from 9.6 in 2000 to 18.7 in 2008 (+95%, 9.1 accrued new studies per 1,000). Other modalities had much lower utilization. In 2000, CT constituted 14% of all ED imaging, but by 2008, it constituted 29%. In 2008, radiologists performed 96% of all ED imaging examinations.⁶

Kung P et al (2005) in their study on “Determinants of computed tomography and magnetic resonance imaging utilisation in Taiwan” investigated the factors that affect MRI and CT utilisation, such as whether supply-side factors have more impact than demand-side factors, and the effect of control policies. Multiple regression analysis was used to determine the relative factors that influence CT and MRI utilisation. It was found out that for :- (a) CT: population ratio, hospital-based physician : population ratio, female ratio, pediatric (≤ 14 years) : population ratio, and family income significantly influenced CT utilization. (b) MRI: population ratio and hospital-based physician : population ratio, female ratio, and family income significantly influenced MRI utilization. However, the proportion of the aged (≥ 65 years of age) did not significantly influence CT or MRI utilization after controlling for other factors. The rates of CT and MRI utilization for the outpatient and inpatient settings and the repeated uses of CT or MRI have decreased significantly after a utilization review was implemented by BNHI, which suggests that CT and MRI have been overused. However the study was concluded with the statement that increase in supply-side factors significantly increase CT/MRI utilisation and supply-side factors impact CT/MRI utilisation more than demand-side factors.⁷

RATIONALE OF THE STUDY

Radiology modalities of investigation though contribute a lot in diagnosing various diseases accurately and improving the overall health of the people but such technological equipments are very costly which need to be justified. India being a developing country has constrained resources, therefore, every effort must be made for proper utilization of these equipments in appropriate manner.

AIM

To increase the efficiency and effectiveness of radiology department in Shalby hospital, Ahmadabad

OBJECTIVE

- To study the utilisation of various modalities (X-ray, CT, MRI and USG) in radiology department so as to calculate the utilisation coefficient of these modalities.
- To identify the factors related to underutilisation of modalities in radiology department
- To compare the target vs actual revenue generation for the underutilised radiology equipments

METHODOLOGY

For this study, data was collected to study the utilisation of various modalities in radiology department, for the duration of two months i.e February to March 2016 through direct observation and from HIS (careworks). The utilisation trend for the underutilised modalities was then studied so as to know the fluctuations in the utilisation coefficient of those modalities. In order to study the utilisation trend, data for the last one year (2015) was taken. Moreover, to identify the factors related to the underutilisation of the equipments, perception based analysis was done in which questionnaire was prepared to ask the staff of the radiology department for the same. As per the secondary research, following were the factors:- breakdown of equipments, increasing competition, untrained human resources, higher rates, lack of awareness for other specialities among public.

Study Design – Analytical study

Study Duration – 1st February, 2016 to 30th April, 2016 (3 months)

Study Area – Radiology Department, Shalby Hospital, Ahmedabad

Inclusion Criteria –

- All the MRI & CT scan done during working hours i.e 8 a.m to 8 p.m

- All the X-ray & USG procedure done during working hours i.e 8 a.m to 8 p.m

Exclusion Criteria -

- All the scans and procedures done in Emergency department after 8 p.m (working hours)
- All the scans and procedures done during Public holidays or on Sundays.

Data Collection –

- **Primary Data:-**
 - Direct Observation
 - Staff of the radiology department was asked about the factors related to the underutilisation of the modalities of radiology department through a questionnaire.
- **Secondary Data :-**
 - Hospital Records {Hospital Information System (HIS) – Careworks software and Registers}

Tools & Techniques -

1. Utilisation Coefficient :-

- Utilisation essentially means the use of the equipment to full potential. Utilisation coefficient is one of the important parameters to monitor the functional status of the equipment, the parameter to assess the productivity of a service or equipment.
- The utilisation Coefficient, if lower than 50% marks underutilisation of that equipment.

$$\text{Utilisation Coefficient} = (N/M) \times 100$$

Where,

N = Average number of hours the equipment is used per day

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

- Average hours equipments used per day is calculated by :-

$$\text{Avg.hrs. per day} = (\text{Avg. time per scan}) \times (\text{Avg. scans per day})$$

Where,

$$\text{Avg. time per scan} = \frac{(\text{Total time taken by all scans done for the month})}{(\text{Total number of scans done for the month})}$$

$$\text{Avg. Scans per day} = \frac{\text{Total no. of scans done for the month}}{\text{Total working days month}}$$

2. To identify the factors related to underutilisation of modalities in radiology department.

- Perception based analysis was done in which the staff of the radiology department were asked questions that out of the given factors, which one was mostly related to underutilisation of the equipments.
- Total number of staff in radiology department = 25
(Clinical manager, Radiologists, Nursing, Executives, Technicians, Medical transcriptionist, Attendants)

3. Target vs Actual revenue amount during the period of two months i.e February & March, 2016 was calculated by :-

- Target = Total no. of scan (Target) / Average rate per procedure or scan
- Actual = Total no. of scan (Actual) / Average rate per procedure or scan

FINDINGS

- To study the utilisation of various modalities (X-ray, MRI, CT and USG) in radiology department, Shalby Hospital

- 1.1. Utilisation coefficient of modalities (X-ray, MRI, CT and USG) in radiology department, Shalby Hospital

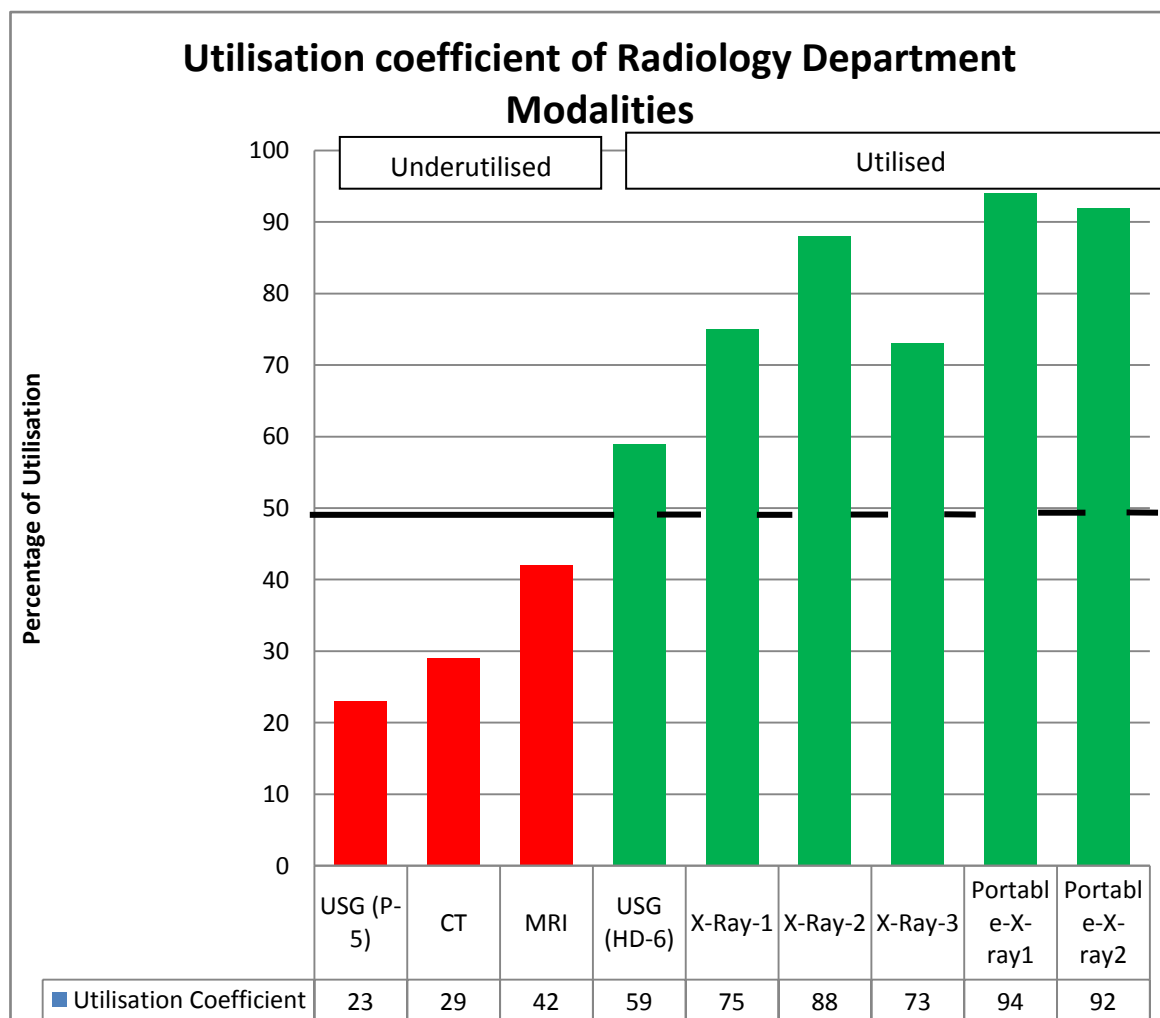


Fig. 1.1 Utilisation co-efficient of various modalities

The graph in Fig 1.1 depicts the utilisation coefficient of various modalities of radiology department. As per Chaudhary P et al (2014), any equipment is considered to be utilised efficiently if the utilisation coefficient is 50% or above. The graph in Fig. 1.1 shows that all the X-ray machines and USG HD6 are considered to be utilised optimally as their utilisation coefficient is above 50% but CT scan, MRI and USG (P-5) are underutilised at 29%, 42% and 23% respectively.

1.2 Comparison of IP and OP utilisation coefficient of underutilised modalities during February to March, 2016.

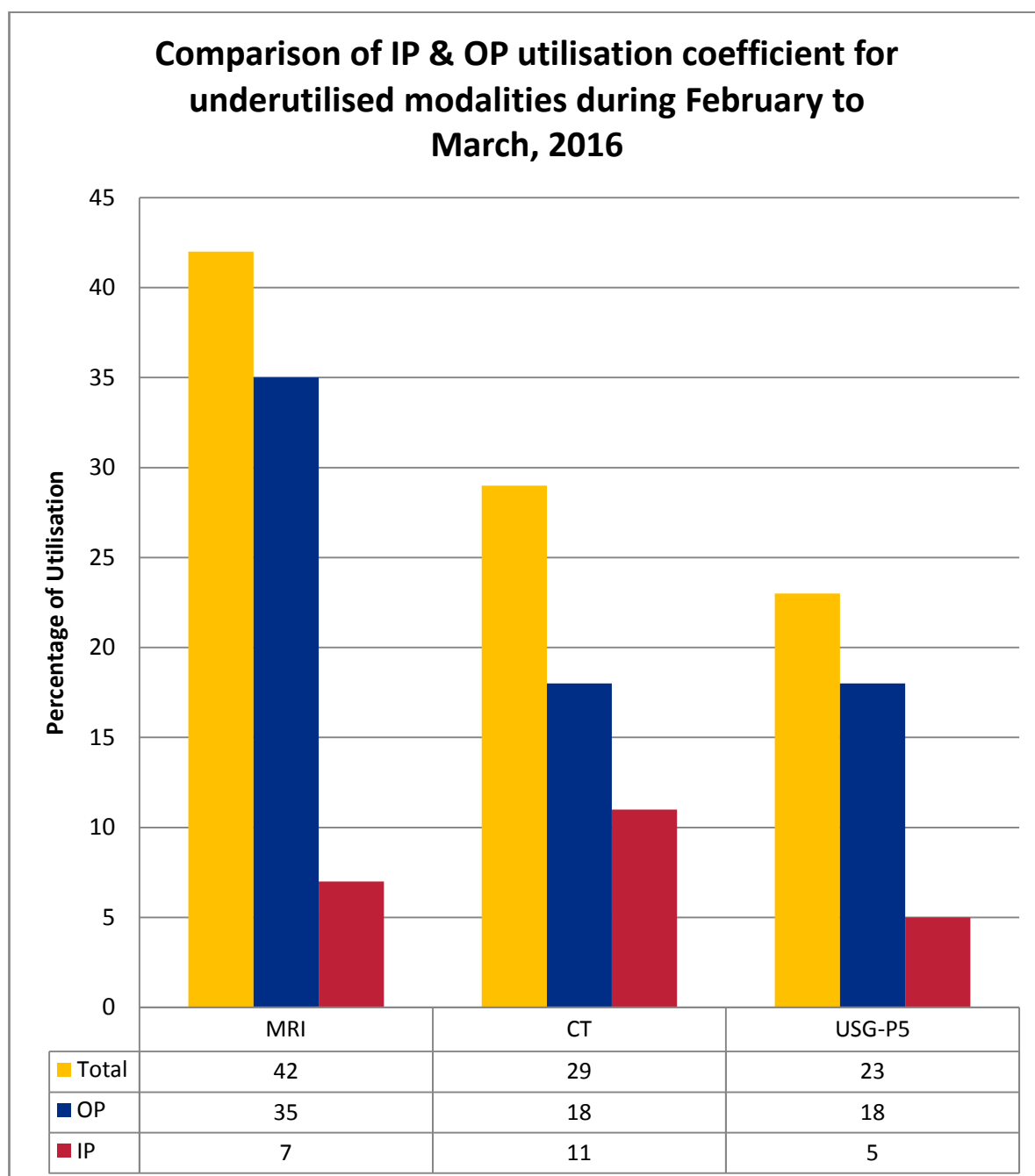


Fig. 1.2 Comparison of IP & OP utilisation coefficient for underutilised modalities during February to March, 2016

The graph in Fig. 1.2 depicts the segregation of utilisation coefficient into IP and OP, so as to know from which department, comparatively more patients are coming for the diagnostic services. In all the three modalities (MRI, CT and USG P5), the patients are more from OP department.

1.3 Utilisation Trend of Underutilised equipments:-

In order to study the utilisation trend of underutilised modalities of radiology department, the retrospective data analysis for the last one year i.e 2015 was done. Moreover to know the fluctuations in utilisation coefficient, comparison of utilisation trend for 2015 and 2016 was done during the period of 2 months i.e February and March.

1.3.1 CT Scan

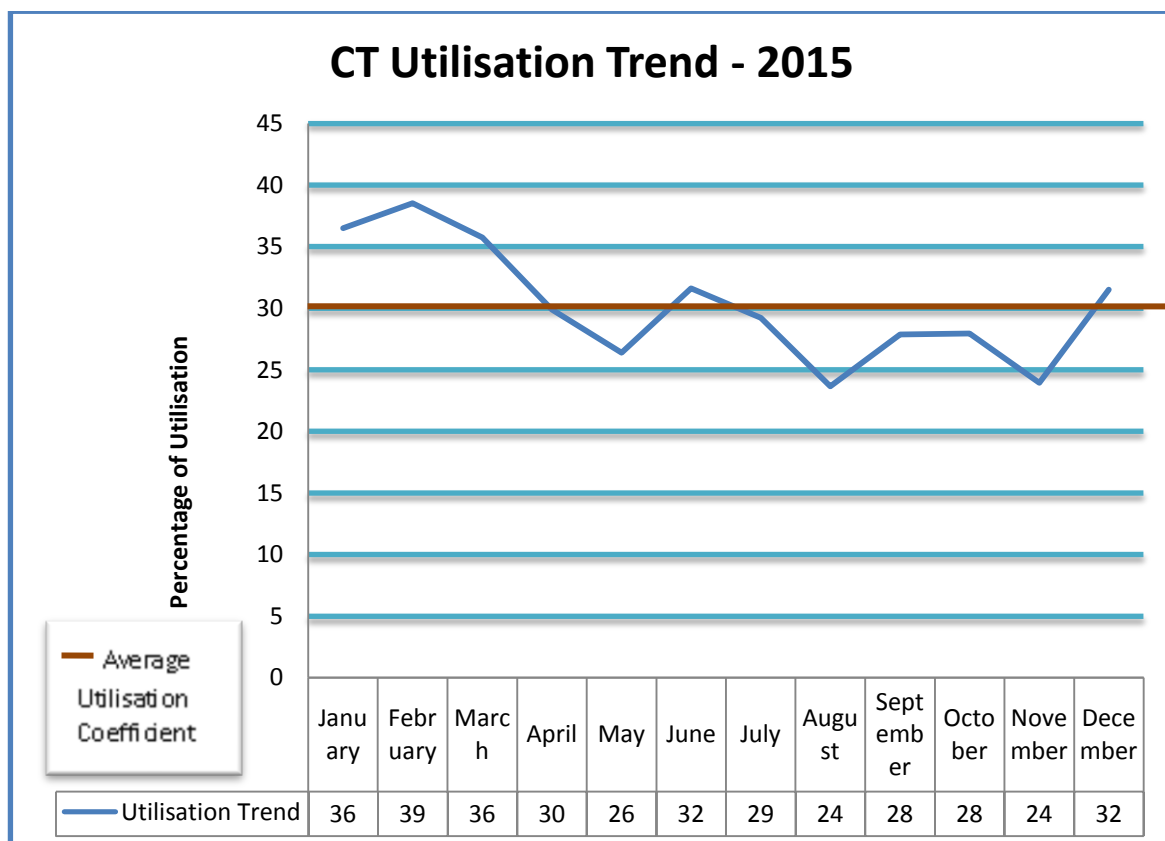


Fig. 1.3 CT Utilisation Trend for the entire year of 2015

From the Fig. 1.3, it can be seen that in the whole year (2015), the utilisation coefficient of CT machine has not even reached upto 50%. The average utilisation of CT scan for 2015 was 30% with maximum being 39% in the month of February and minimum in the month of August and November i.e 24 %.

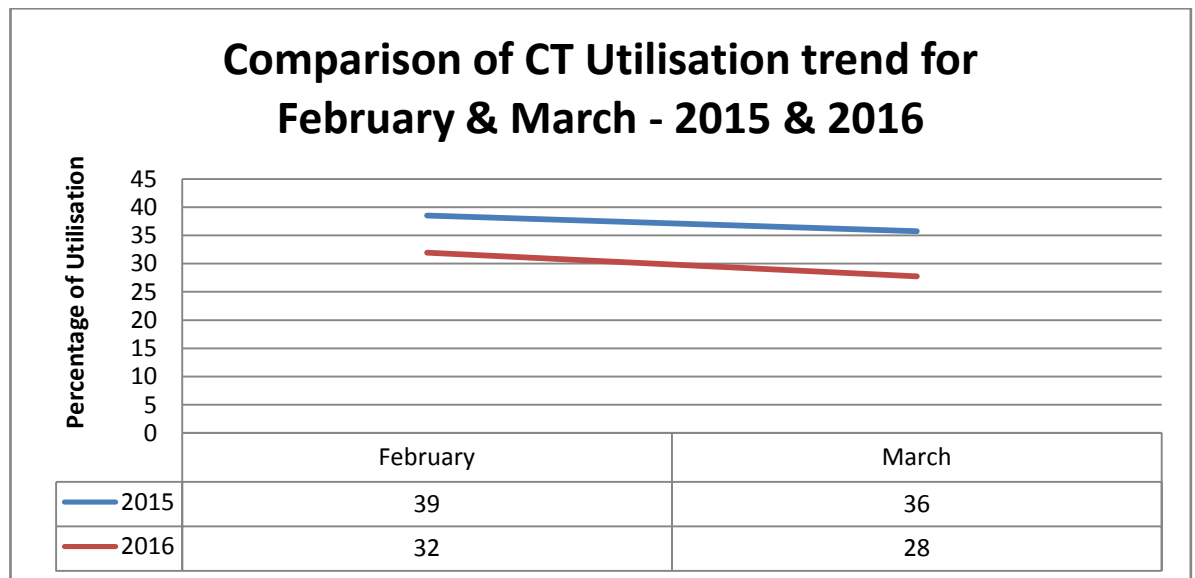


Fig. 1.4 Comparison of CT utilisation trend for February and March - 2015 and 2016.

As shown in Fig. 1.4, the utilisation percent of CT scan for the both months of February and March 2016 have dropped as compared to last year utilisation coefficient.

1.3.2 MRI Scan

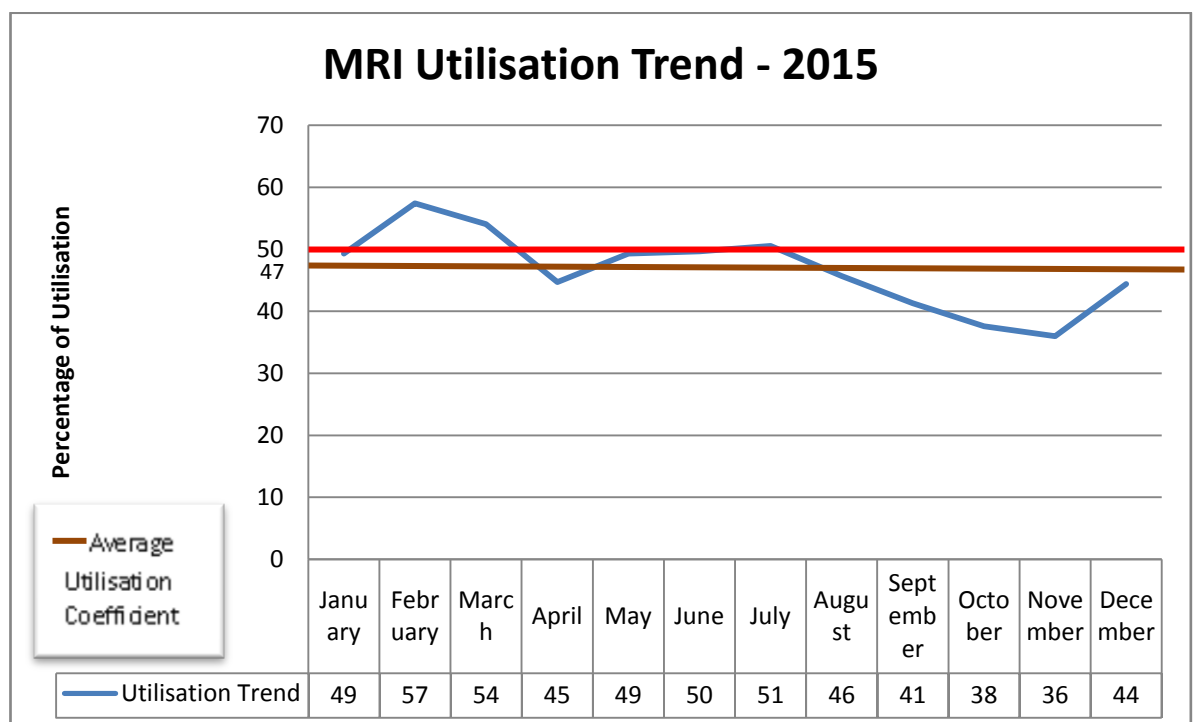


Fig. 1.5 MRI Utilisation Trend for the entire year of 2015

As shown in Fig 1.5, MRI utilisation coefficient was above 50% in the month of February, March, June and July, which indicates that it has been utilised optimally last

year as compared to other underutilised machines. However, the average utilisation of MRI scan for 2015 was 47%, with maximum being 57% in the month of February and minimum in the month of November i.e 36%.

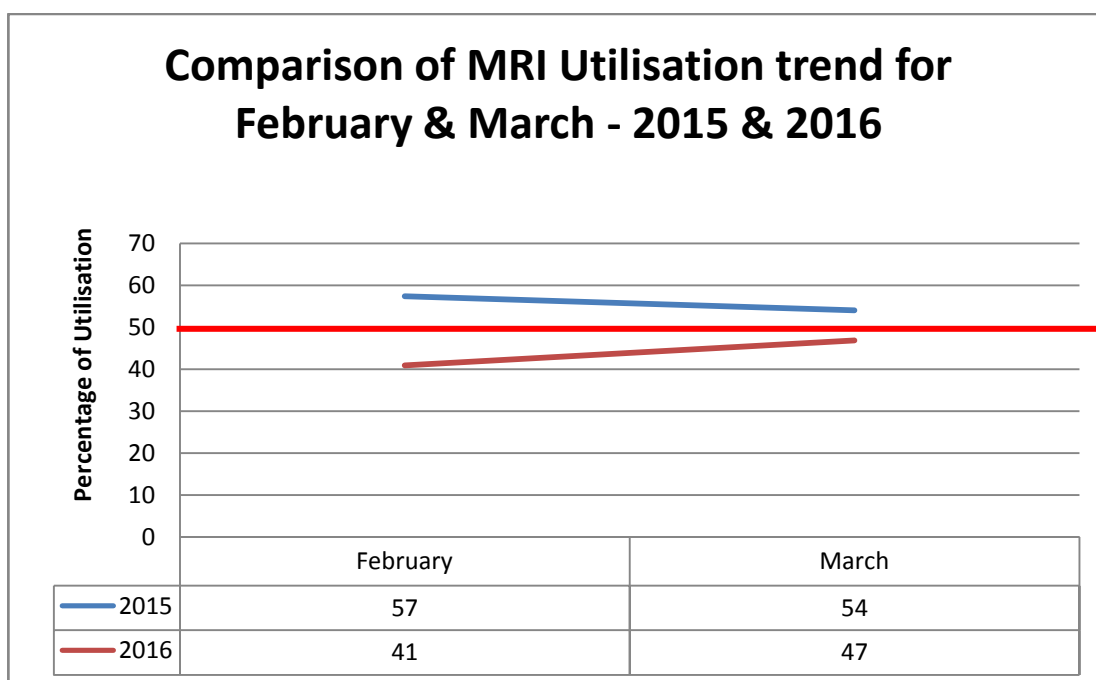


Fig. 1.6 Comparison of MRI utilisation trend for February and March – 2015 and 2016

As shown in Fig. 1.6, MRI machine for February and March 2015 was utilised efficiently i.e above 50% but its utilisation coefficient has dropped for both the months (February and March) of year 2016.

1.3.3 USG (P-5)

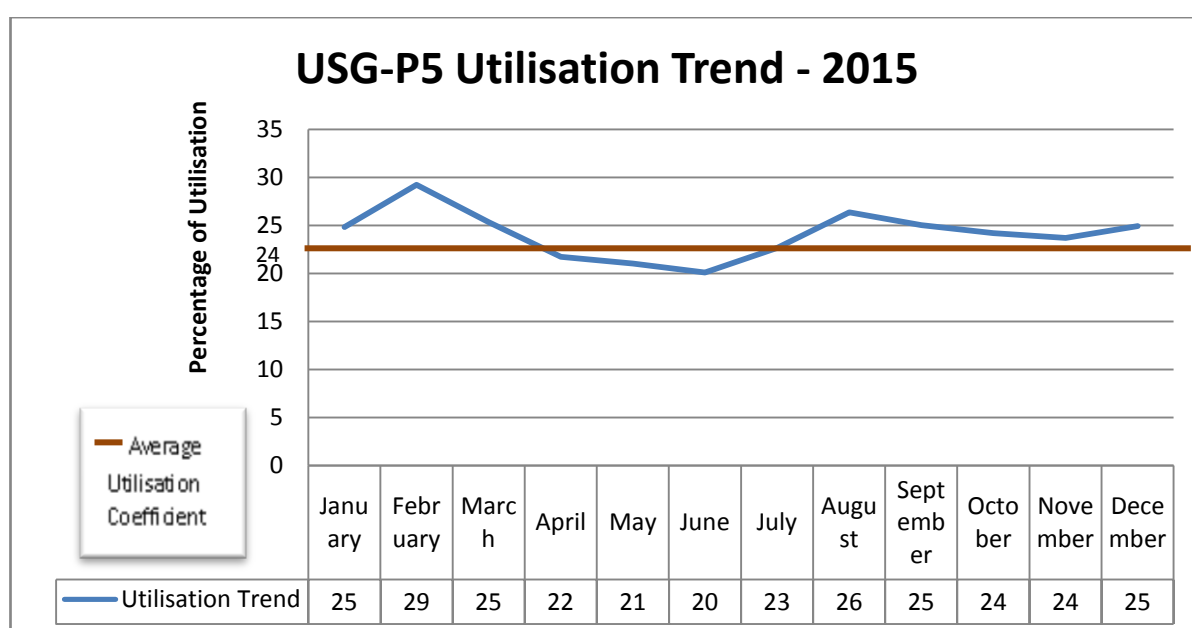


Fig. 1.7 USG-P5 Utilisation Trend for the entire year of 2015

As shown in Fig. 1.6, the average utilisation of USG for 2015 was 24% with maximum being 29% in the month of February and minimum in the month of June i.e 20%. The utilisation coefficient of USG-P5 for the entire year has not even touched 50%.

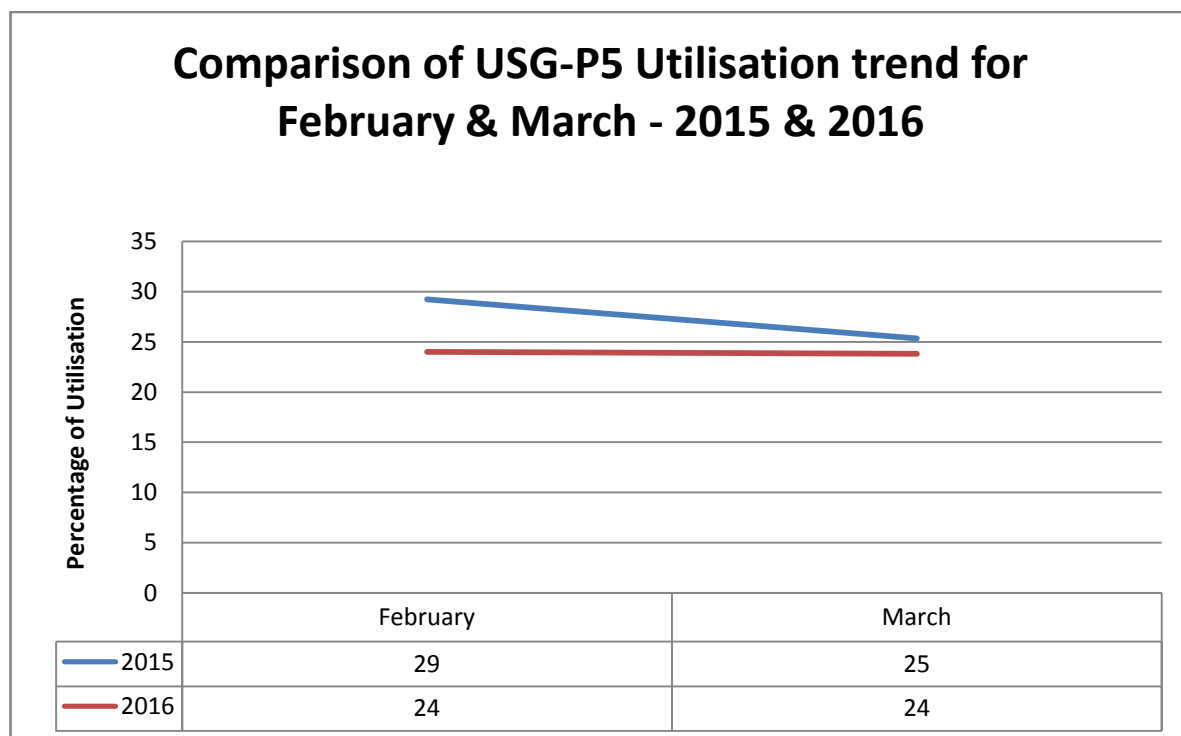


Fig. 1.8 Comparison of USG-P5 utilisation trend for February and March – 2015 and 2016

As shown in Fig 1.8, the utilisation coefficient of USG P5 machine for both the months in 2016 have dropped as compared to last year 2015.

2. To identify the factors related to underutilisation of modalities in radiology department, Shalby hospital

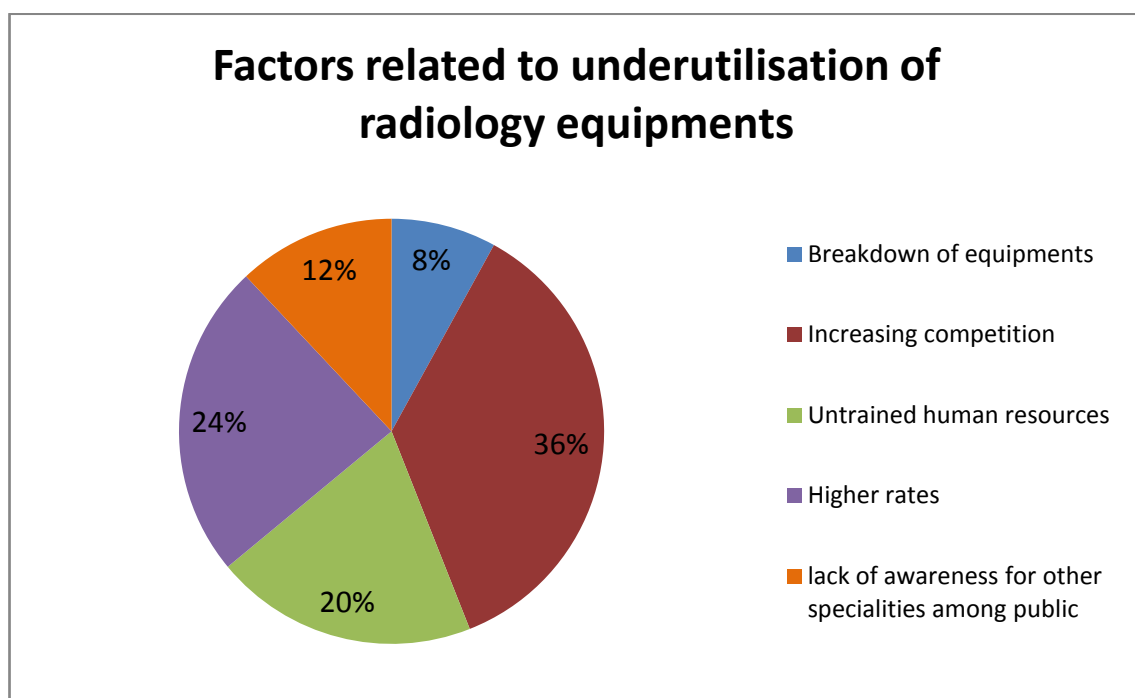


Fig. 1.9 Percentage of responses regarding the factors related to underutilisation of modalities in radiology department

As shown in Fig. 1.9, according to the staff in radiology department, major factor related to the underutilisation of modalities is increasing competition (36%) followed by higher rates (24%) and untrained human resources (20%).

3. To compare the target vs actual revenue generation during the period of 2 months (February & March, 2016) for the underutilised radiology equipments

During the period of 2 months (February and March 2016)	Target	Actual	Avg. Rates of each procedure/scan (rupees)
Utilisation Index	50%	42%	MRI – Rs.6500/-
Total No. of Scan	503	426	
Utilisation Index	50%	29%	CT- Rs.4500/-
Total No. of Scan	743	428	
Utilisation Index	50%	23%	USG - Rs.1350/-
Total No. of Scan	975	458	

Tab. 1.1 Target vs Actual revenue generation for underutilised equipments (February & March 2016)

3.1 MRI revenue generation (Target vs Actual) (during the month of February to March, 2016)

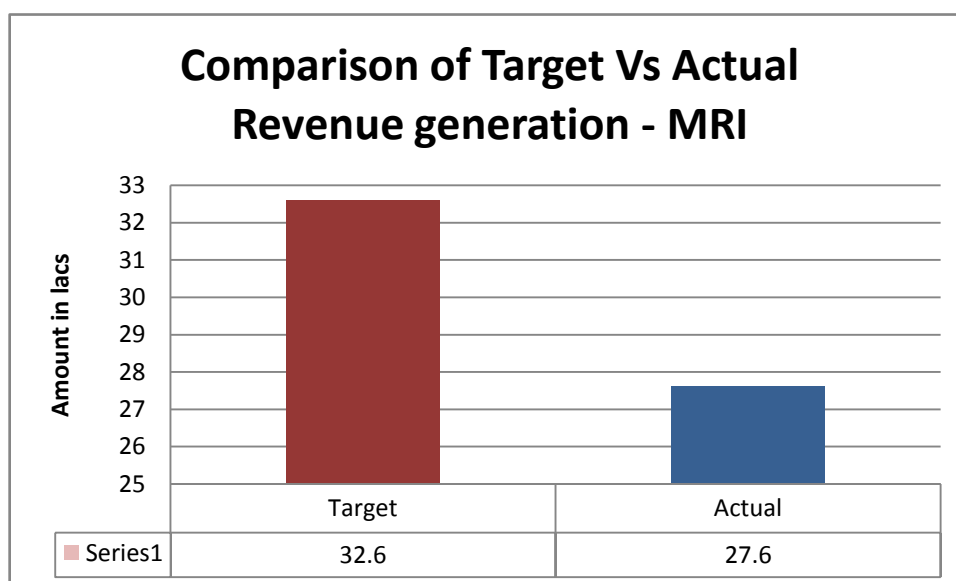


Fig. 1.10 Comparison of Target vs Actual revenue generation for MRI machine

3.2 CT revenue generation (Target vs Actual) (during the month of February to March, 2016)

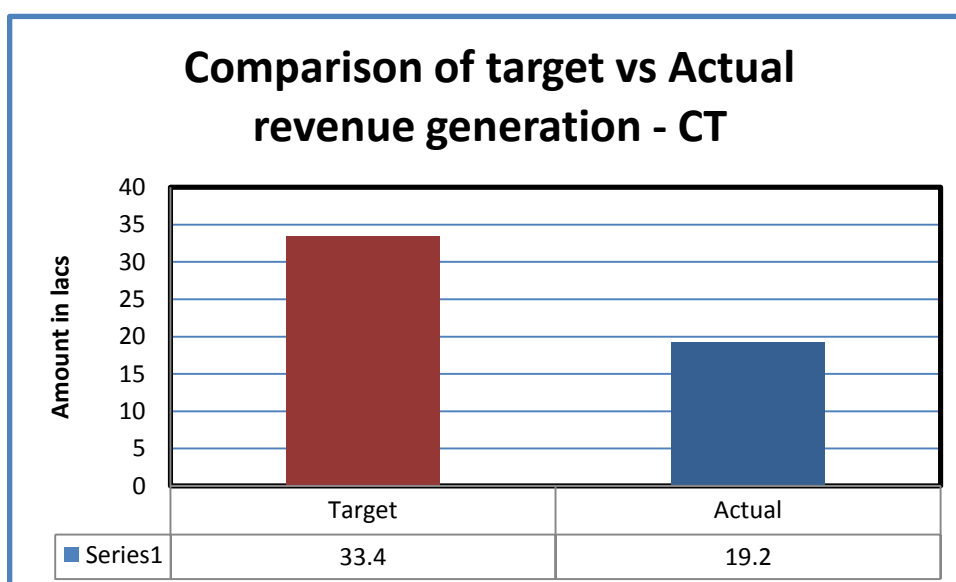


Fig. 1.11 Comparison of Target vs Actual revenue generation for CT machine

3.3 USG (P5) revenue generation (Target vs Actual) (during the month of February to March, 2016)

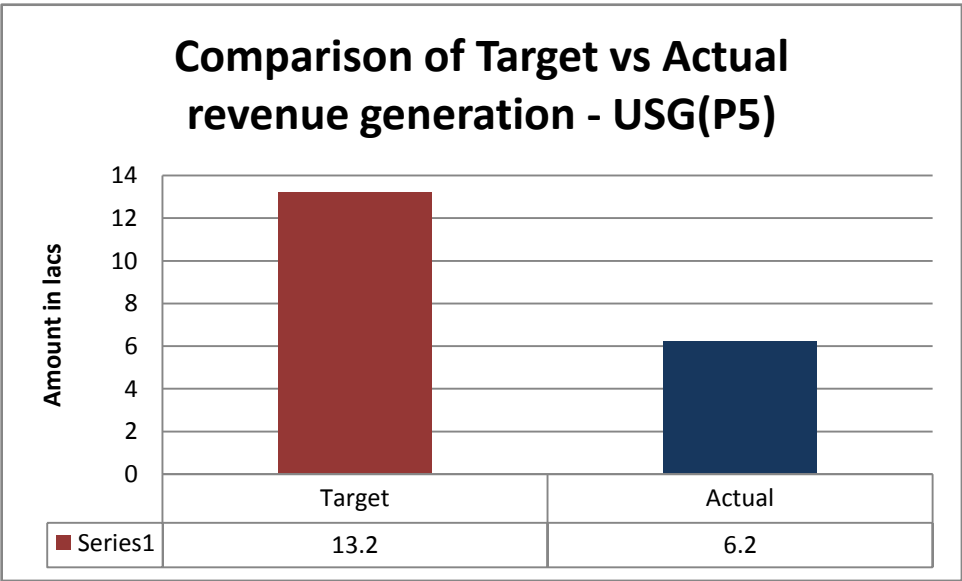


Fig. 1.12 Comparison of Target vs Actual revenue generation for USG-P5 machine

ETHICAL CONSIDERATION

This is to ensure that the confidentiality of data has been maintained throughout the study. Before interviewing the staff of the radiology department, proper explanation about the purpose of the study has been given to them.

DISCUSSION

The objective of the study was to assess the utilisation coefficient of various modalities in radiology department and identify the factors that causes the low utilisation of modalities along with analysing the utilisation pattern of underutilised equipments. The above objectives were mainly to get the clear picture on which modalities were underutilised constantly as radiology equipments are very costly whose proper utilisation need to be ensured in order to maintain the efficiency and effectiveness of the department.

Out of 4 modalities being assessed, all the X-Ray machines have the maximum utilisation co-efficient ranging from 73% to 94%. Whereas, in USG machine only one machine i.e HD6 showed the utilisation coefficient of 59% and other machine P5 showed the underutilisation rate of 23%. MRI and CT scan are also utilised with 43% and 29% respectively.

Identification of the factors related to the low utilisation of modalities (MRI, CT and USG P5) in radiology department have been carried out. Based on perception based analysis, it was found out that majority of the staff in radiology department agreed to the fact that low number of patients (36%) was one of the main factors for the low utilisation of modalities, followed by higher rates (24%) and untrained human resources (20%), whereas as lack of awareness about other specialities among public (12%) and breakdown of equipments (8%) contributed very less in causing the underutilisation of modalities. As many new diagnostic centres and new hospitals have come up around the vicinity of the Shalby hospital, it has majorly affected the utilisation rate of imaging modalities. Moreover, rates for imaging services in Shalby hospital is higher as compared to other hospitals and diagnostic centres like CT machine in shalby hospital is of 128 slices where as in other hospitals it is ranging from 64 slices to 120 slices, thus charging higher rates for the same and all the radiology equipments have been imported from companies like Siemens and GE which further contributes to higher costs.

Shalby hospital being superspecialised in joint replacement, majority of public have lack of awareness about its other specialities such as neuroscience, general surgery, ophthalmology etc.

All these factors have greatly affected the revenue generation of underutilised modalities (MRI, CT and USG P5) ultimately leading to loss of hospital.

CONCLUSION

Out of 4 modalities i.e X-ray, MRI, CT and USG, all X-ray machines and USG HD6 are found to be utilised optimally whereas, MRI, CT and USG P5 are underutilised (less than 50% of utilisation coefficient). Therefore, there is a need of increasing the efficiency in radiology department of Shalby hospital, Ahmedabad.

SUGGESTIONS

- The modalities which are underutilised due to paucity of workload should be shared with other hospitals.
- There is need of restructuring the pricing of the services, and various schemes and discounts can be given to the patients.
- Proper training of human resources related to the process flow of radiology department
- Need to focus on the marketing of other specialities

LIMITATION OF THE STUDY

- The cost analysis of the modalities of radiology department was not included in this study
- The scans and procedures done after 8 p.m could not be included in the study.

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