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Assessment of operation theatre complex efficiency and utilization at a 750 bedded multispeciality hospital, Mumbai, India

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ABSTRACT

Introduction: The operation theatre complex of a hospital represents an area of considerable spending in a hospital budget and requires utmost utilization to guarantee optimum cost benefit. Operating room (OR) functions with a lot of resources. Thus, any form of inappropriate functioning will cause revenue loss as well as decreased quality of patient care and satisfaction. Any delay in the Operation theatre is detrimental to the image and overall functioning of the hospital and ways to reduce the delays are a key to improve patient care and to maximise consumption of the resources in operating room

Objective: To determine OR utilization and efficiency in the OT complex.

Methodology: A prospective study was done from 1st May 2019 to 15th May 2019 in the OT complex of a 750 bedded Multispecialty Hospital in Mumbai, India. OT utilization and efficiency over a time period of two months was studied with respect to number of operation theatres, working hours in that particular study period, OR working capacity, Utilized hours..

Results: Collected data showed that ORs were serviceable for 52 days through the study period and in that period 726 cases were operated. Total OR utilization time was 1820 hours for the study period. Collected data showed that in a two-month period from 1st May 2019 to 30th June 2019 there was the highest utility of 58% (OR 2) whereas there was the lowest utility of 27 % (OR 3) in the 5th floor OT complex. However, considering the entire 5th floor OT complex, actual utilized OT hours were only 655 out of the available 1820 hours during the study period. Thus a utility of 36% only was seen.

Conclusion: Integrated time management and time utilization will result in a cost reduction, increase in hospital revenues with improved quality and patient satisfaction. Improving the performance of operating theatres is key to achieving shorter waiting times for treatment, implementing booking of elective operations and reducing canceled operations. Any delays in the operation theatre are detrimental to the image and overall functioning of the hospital and different methods to reduce these delays are a key to improve patient care which will eventually maximise consumption of the resources in the operating room.

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INTRODUCTION

An operation theatre (operation suite) is a medical facility where procedures are conducted in a strictly aseptic environment. The operation theatre (OT) complex is a high-cost item in a hospital's budget. To achieve the best cost-benefit ratio, this sector of hospital activity must be utilized to the fullest extent possible. OT is reported to be the key source of revenue generated in any hospital, accounting for 50 percent to 60 percent of total revenue. To achieve a high level of utilization in the OT, a variety of activities and individuals must be coordinated effectively.[1]

As a result, it's a good idea to boost these assets' efficiency. It's concerning when scheduled operations are unexpectedly canceled at the last minute, even on the morning before surgery. The inefficient utilization of operating room time and loss of resources is exacerbated by late cancellations of scheduled surgeries. It is also potentially unpleasant, with depressive effects, as well as costly to the patient in terms of lost days of work and daily life disruption.

To achieve a high degree of efficiency in the OT, a variety of tasks and resources need to be organized effectively [1] The efficiency of OTs can be measured in a different number of ways. Principally, it tends to be defined in terms of its ability to translate available hours into earnings.[2-4] Utilization is a simple

KEYWORDS:
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and adequate measure of the efficiency of a theatre, because its ability to generate revenue rises as the time for which it is used increases.

This study records that various causes of cancellations and delays of surgeries are avoidable, and efforts should be taken to prevent cancellation of surgery by vigilant planning and consumption of human and material resources. Important factor in the cancellation of operations was the lack of separate facilities for day-case treatment, because the same OT was used for in-and out-patient operations.[2, 3]

Delays in starting the surgeries in the morning cause considerable wastage of productive OT time and lead to cancellations of surgeries in the later part of the day, which in turn hampers the daily OT utilization. Therefore, proper communication among surgeons, anesthesiologists, and nursing staff on the night before surgery can help in morning delays.

Room turnover time can be improved by keeping a dedicated theatre for emergency procedures. The availability of a dedicated theatre for emergency procedures avoids delay and cancellation of previously scheduled elective procedures. Along with this adequate staffing and meticulous pre-anesthetic checkup and proper screening of patients pre-operatively, proper arrangements for blood and blood products, ICU backup required instruments, and linen beforehand can go a long way in avoiding last moment cancellations.

Studies have reported that the single most important factor for canceling cases was the dearth of operating time. This was due mainly to the fact that surgeons took longer than the expected length of the procedure. [12]Research has shown that measurement of preoperative anesthesia in pre-anesthesia clinics significantly reduces delays and cancellations in operating rooms.[8]

The global shortage of nurses today has a detrimental effect on the global health systems. The rapid expansion of educational and health service organizations creates a major gap as teachers, service providers and administrators in terms of human Resource for health (HRH). [9].This has an overall impact on coordination amongst the staff especially in critical departments like an OT complex, which indeed affects the overall functioning of that OT system.[10-12]

Efforts by nursing leaders to build supportive work environments will affect the ability of nurses to practice professionally, ensuring excellent quality of patient care and successful organizational outcomes and maintaining interpersonal relationships.[13-15] These interrelationships play an important role in OT complexes thus increasing their performance and allowing maximum use.

In addition, this objective allows the hospital to increase mounted resource returns and thus helps to improve this service's performance. The constraints require available time in the operating rooms and available time for the doctor.[16, 17] The availability of material resources (i.e., operating rooms, beds and equipment for post-anesthesia), the availability of surgical staff, departmental integration and skills of surgical staff and patient priorities are several factors that cause cab problems in the scheduling of the operating room.[18]

Some factors for inefficient utilization are doctor's tardy arrival, defective coordination, and communication gap. So also surgical doctors felt the dearth of preparation of OT complex on time is responsible for start time operational delay, lack of qualified surgeon staff similarly nurses were found to have similar reasons when it came to delays in operating theatre.[19] These can be prevented with careful preoperative preparation and patient and resource optimization, as well as good communication between surgeons, anesthesiologists and nursing staff[20]

The allocation of resources to both elective and emergency theatres requires changes personnel recruiting needs to be assessed and internal assessments within organizations need to be performed to identify ways to optimize the productive time of a theatre complex to improve overall OR (operating room) efficiency [21]

The current study addresses all such issues in the Operation theatre complex and brings out factors affecting efficiency and utilization.

METHODOLOGY

This study was channeled in an Operation Theatre complex of a 750-bedded tertiary and teaching hospital in Mumbai, Maharashtra. The OT complex consists of seven major OTs.

Working hours for routine scheduled elective cases are from 8.00 a.m. to 6.00 p.m. on all working days except Sundays and public holidays. The duty hours of internship were from 8 a.m. to 5:30 p.m. The data post these hours was obtained from the OT registers that were duly maintained by the OT department.

This study was conducted over a period of 1st May 2019 to 30th June 2019 (sample collection till 15th June 2019). The observation was recorded only for scheduled routine cases, which were scheduled on the list on the previous day till 8 pm. The OT complex primarily had 10 working hours from Monday to Saturday

Every first case of each of the seven ORs was live tracked and its time mapping was done from the patient's point of entry in the OR to his point of exit. Observations were not made on Sundays and gazette holidays.

The hospital had a policy of writing the data in the scheduled register. The data of the previous day was reviewed by me every day through these registers and nursing staff assistance.

Based on these parameters following data was obtained: **OT Capacity** = No. Of Days* No. Of OT* No. Of Hours; **OT Utilization** = Total No. of Hours for each patient in each OT/total period; **Utility** = OT Utilization/OT Capacity *100

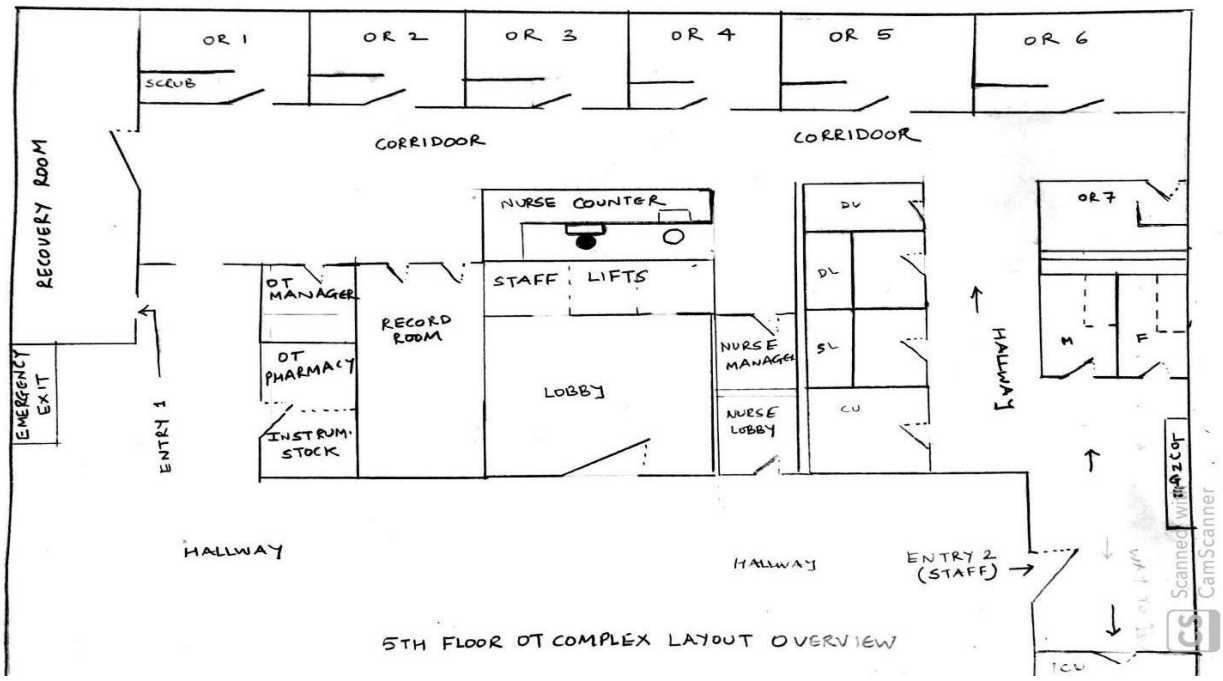
The following were noted for each scheduled case for that day on that table

OR Start time - The time at which the patient is taken inside the OR.

OR End time - The time at which a patient is brought out of the OR.

TAT (Turnaround time) – The time lag between OR end time of earlier patient and OR start time of the next patient. This is also referred to as turn over time (TOT)

Diagram 1: Layout of the studied OT complex



(Based on previously mentioned layout)

OT delays – The first case for every particular OR (seven ORs) was live tracked to find out the delays in the scheduled time for that particular OR so also reasons for the same were noted.

If any case gets canceled or rescheduled, the reason was noted down. The most common causes of delays were studied and analyzed. Consider the following process flow.

CU – Clean Utility; **DU** – Dirty Utility; **SL** – Sterile Lift for sterile Instruments from CSSD to OT; **DL** – Dirty lift for dirty Instruments from OT to CSSD; **OR** - Operating Room; **ICU** – Intensive Care Unit.

The Layout is mentioned so as to understand the process flow from Wards to Operation Theatre Complex to Operating room. The layout of 5th floor OT complex shows the above mentioned areas followed by seven operating rooms, staff lifts, Recovery room, stock room for drugs and instruments, toilets and changing room, for the staff, broad hallways, record room, nurse station, rooms for OT manager and nurse manager, two separate entries leading to operating room corridor, entry to the ICU. Emergency exit. However there is an extension for this layout since the entire 5th floor is dedicated to the OT complex. But the part of layout that helped during the study is only mentioned.

Medical records of the patients were obtained from the OT register maintained in the 5th floor OT complex by the hospital on a daily basis. Live tracking of the first case of every OR was done. The entire process was mapped and OR start time, OR end time for every patient was noted based on real time mapping and TAT in between the cases for every OR was calculated. Sample collection from 1st May 2019 to 15th June 2019, which included 726 surgeries in total conducted in the 5th operation theatre complex. Purposive sampling and convenience sampling was considered for the study. The study was conducted during 2 months in May -June 2019. Microsoft Excel was used as software for conducting the analysis.

The process flow initiates from wards which is the start point for the patient until the patient finally reaches OR that is allotted to him for surgery. The hospital has a policy to get Pre-anesthetic checkup and Lab reports to be made ready a day prior to the surgery which are supposed to happen when the patient is at the start point of the process flow. After having achieved clearance here the respective OT porter carries the patient to the OT complex which is either 3rd, 5th or & 7Th floor as booked by the doctor. He is then supposed to reach the recovery Room half an hour prior to surgery time where he is checked for by the respective surgeon and anesthetist for the same surgery. The patient then enters OR allotted for the surgery. At this stage OR in-time and OR out time are recorded (IST). If at all any case gets delayed or canceled, the reason for the same is analyzed, recorded and attempted to solve.

LIMITATIONS OF THE STUDY

The study was carried out for 2 months only and follow up study could not be conducted to check on improvements.

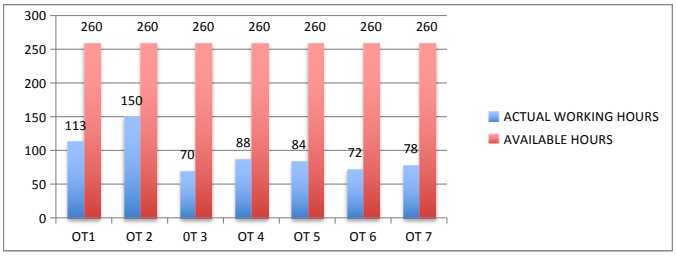
RESULT/FINDINGS

Collected data showed that ORs were functional for 52 days during the study period and in that period 726 cases were operated. Total OR utilization time was 1820 hours for the study period. Collected data showed that in a two month period from 1st May 2019 to 30th June 2019 there was the highest utility of 58% (OR 2) whereas there was the lowest utility of 27 % (OR 3) in the 5th floor OT complex. However, considering the entire 5th floor OT complex, actual utilized OT hours were only 655 out of the available 1820 hours during the study period. Thus a utility of 36% only was seen. The above given findings can be proved in the following graphs and pie diagrams and tables which formulated from the data collected during the study period.

The graph 1 shows that OR 2 has highest utilization whereas OR 3 has lowest utilization. This is based on a prospective study that was done in the span of two months. However the overall utilization of the OT complex is inadequate considering the available working hours of the OT complex. Hence there were a total of 1820 available utilization hours out of which only 655 were consumed in actuality. Thus there was a 36% utility seen during the study period. This shows that the OT complex is under-utilized.

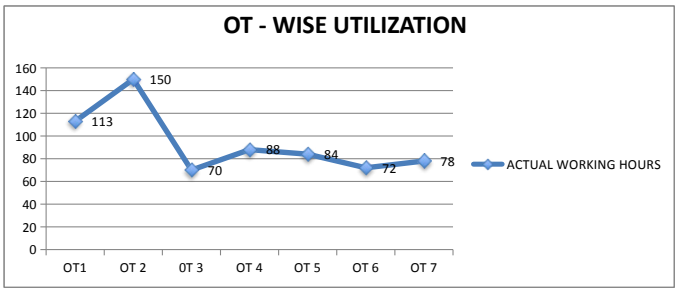
The Diagram 1 shown pie diagram shows that OR 2 has the highest utility of 58% whereas OR 6 has the lowest utility of 27 %. Ideally the hospital could achieve maximum benefits only if the OT complex has 100 % utilization. But then under normal circumstances and other surrounding conditions achieving such an ideal target becomes extremely difficult. Therefore it is extremely important for the Hospital to make sure that its OT complex is optimally utilized to avoid any losses in terms of revenue generation.

Graph 1: OT/OR WISE UTILIZATION



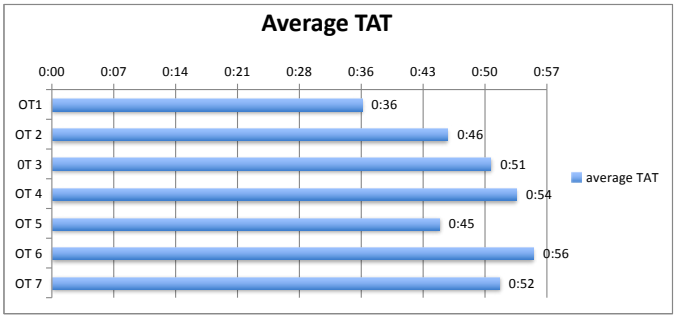
X axis - Operating rooms (1 to 7) in an OT complex
Y axis - No. of working hours

Graph 2: OT/OR wise utilization.



X axis - Operating rooms (1 to 7) in an OT complex
Y axis - No. of Actual working hours

Graph 3: Average Turnaround Time for all the ORs.



X axis - Average Turnaround Time (TAT)
Y axis - Operating rooms (1 to 7) in an OT complex

The graph 3 gives us an insight of OR 6 having a maximum average Turn Around Time of 56 minutes followed by OR 4 having second highest Turn Around Time of 54 minutes; the lowest average being of 36 minutes for OR 1 all of which are more than the set expectations of the management which is around 20 minutes only as mentioned before.

From the previously mentioned table it is clear that OR 1 has a minimum TAT of 0.36 hrs. With a minimal std. deviation of 0.40 hrs. And OR 6 has a maximum TAT of 0.56 hrs. And maximum Std. deviation of 1.22 hrs. The average TAT for the 5th floor OT complex was 0.49 hrs. With a std. deviation of 0.85 hrs. These values are on the higher side.

Hence the maximum value of TAT when calculated with a std. deviation of 0.85 would be | 0.49 + 0.85 | = **1.34 hrs.** And Minimum value of TAT with a std. deviation of 0.85

As calculated will be | 0.49 - 0.85 | = **0.36 hrs.**

The diagram 2 depicts several reasons for the delays in the first case of every OR which is done based on their live tracking done during the study period. It was observed during the study that the majority of the delays caused in the ORs was because the

Diagram 1: OT UTILITY (PERCENTAGE WISE)

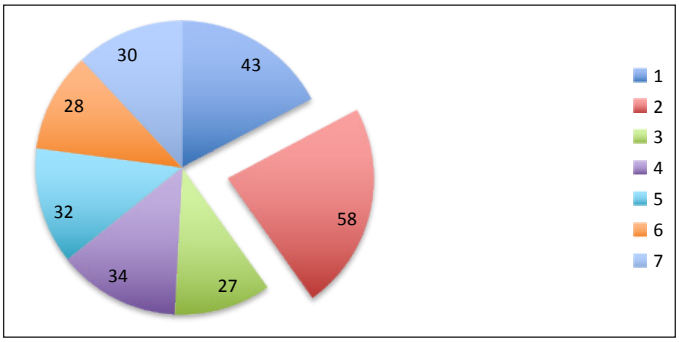


Diagram 2: Reasons -Discrepancy in OT schedule / start time OT delays

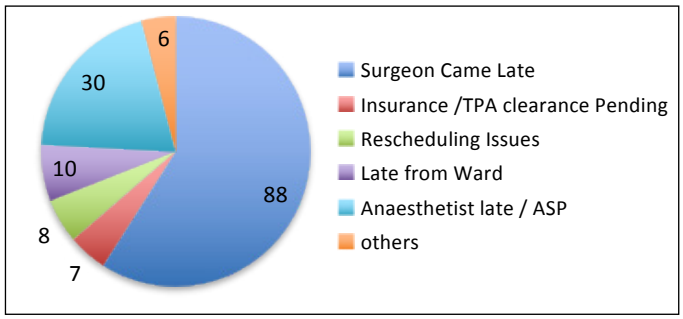


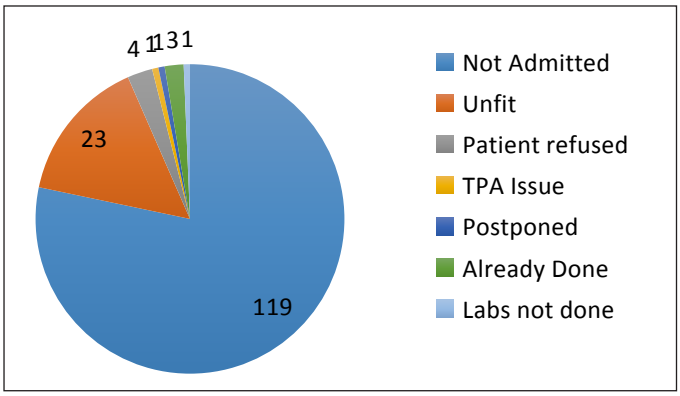
Table 1: Minimum and Maximum TAT for each OR

OPERATING ROOM	*MINIMUM TAT (min)*	*MAXIMUM TAT (hour/ min)*
OR 1	35	2:45
OR 2	25	4:45
OR 3	20	2:15
OR 4	15	5:20
OR 5	15	3:20
OR 6	15	2:25
OR 7	15	5:20

Table 2: Standard Deviation for TAT

5th floor OT complex	*Average TAT (hrs.)*	*STD- DEVIATION (hrs.)*
OR 1	0.36	0.40
OR 2	0.46	0.80
OR 3	0.51	0.99
OR 4	0.54	0.90
OR 5	0.45	0.65
OR 6	0.56	1.22
OR 7	0.52	0.99
Average for 5th floor OT complex.	0.49	0.85

Diagram 3: Reasons for cancellations of the OT procedures



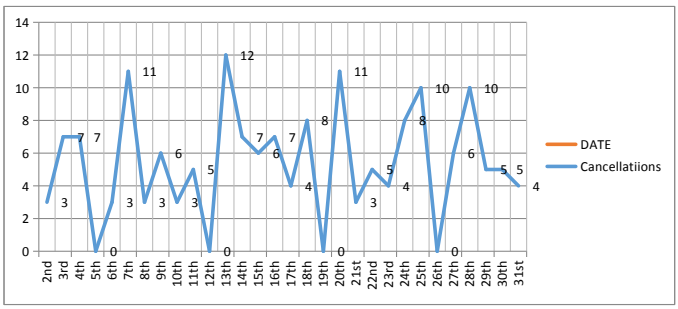
respective surgeons did not arrive on time for the procedure in the OR. This is followed by Anesthetist's pending clearance for the patient. Based on live tracking of every first case in the OR (Ref: Annexures) of fifth floor OT complex during the study period of 1st May to 15th June the following was interpreted: Average delay in every first live tracked case - 33 min. For a Sample size of 170 (First case of 5th floor OT complex during the study period only). Minimum delay that has occurred during the study period is 5 min. Maximum delay that ever occurred during the study period is 2.5 hrs. (Occurred once).

Graph 4 and Diagram 3 gives us an insight about the number of cancellations of the OT procedures and common reasons for the same. It is seen that maximum cancellations (12) occurred on 13th May 2019 whereas the minimum cancellations that occurred through the study period were only 3. The former mentioned numbers of canceled procedures were during the working day phase only. The utmost common reason for cancellation (78% of the cases) was patients not being admitted despite their names on the OT list. The other most common reason being medical reasons (unfit patient) of the patient (15% of the cases).

DISCUSSION

In the study conducted in a 750-bedded super specialty hospital (5th floor OT complex) in Mumbai it was observed that OR 2 has the highest utility of 23% whereas OR 2 has the lowest utility of 11%. Ideally the hospital could achieve maximum benefits only if the OT complex has 100 % utilization. But then under normal circumstances and other surrounding conditions achieving such an ideal target becomes extremely difficult. Therefore it is extremely important for the Hospital to make sure that its OT complex is optimally utilized to avoid any losses in terms of revenue generation. The surrounding conditions

Graph 4: OT Cancellations per day



that affected included end time cancellations of the elective surgical procedures, discrepancies in the TAT, start time OT delays, improper staff coordination. The most common reason for delays in the OT were because of the surgeons who did not arrive on time as per their scheduled OT, followed by PAC not being done by the anesthetists, increased turnover time and so on.

The average TAT for the 5th floor OT complex was 0.49 hrs. With a std. deviation of 0.85 hrs. These values are on the higher side. Hence the maximum value of TAT when calculated with a std. deviation of 0.85would be | 0.49 + 0.85 | = **1.34 hrs**. And Minimum value of TAT with a std. deviation of 0.85 as calculated will be | 0.49 - 0.85 | = **0.36 hrs.** OR 1 has a minimum Average TAT of 36 minutes and the other ORs should focus to improve their TAT and achieve an ideal TAT of 36 minutes. However it is recommended that further studies need to be conducted on this ideal TAT (36 min) for a longer period of time so as to achieve better conclusions. A prospective real time analysis is recommended for a longer period of time.

The study showed that there were 163 cancellations out of a total 726 cases in the study period that counted to almost 23% of the canceled cases, approximately one third of the cases. The major reasons for cancellations found in my study were due to unauthentic OR lists. Many of the patients that were found to be on the OT list for that particular day were actually not admitted (78% of the total cases). The hospital under the study has a HMIS system that helps surgeons put their patients on the OT list as per their schedules and their OT time slots. However the HMIS system does not consider the fact that the patient has not paid any of the booking charge or any prior fees that is necessary to be paid for their procedure to be actually conducted in the OT. This led to an increase in the number of entries of the patients on that OT list, one third approximately of which got canceled. This in turn led to wastage of OR time. Therefore it was realized that authentic scheduling of OT plays an important part in improving OT efficiency and indeed OT utilization. Other reasons for cancellations being medical reasons of the patient (15%), patient refusal (3%), TPA issue and others (1%). Indeed improving management of the operation theatre procedure list, rescheduling of the operating room, reducing patient pathway time, reinforcing Daycare Surgery plan and establishing Pre-anesthesia checkup room, improves the total OR efficiency [27]

OR 2 has the highest utility of 58% whereas OR 6 has the lowest utility of 27 %. Ideally the hospital could achieve maximum benefits only if the OT complex has 100 % utilization. But then under normal circumstances and other surrounding conditions achieving such an ideal target becomes extremely difficult.

Therefore it is extremely important for the Hospital to make sure that its OT complex is optimally utilized to avoid any losses in terms of revenue generation.

Following recommendations were made so as to improve TAT, reduce cancellations and delays and improve overall OT efficiency. As per the previously mentioned calculations it is recommended that the hospital should aim for lesser TAT i.e. 0.36 hrs. So as to improve OR utility. (Many a time TAT was as high as 4-5 hours)

Further studies need to be conducted considering 0.36 hrs. As an ideal TAT. The surgeon was asked to take a look at the cases he is going to perform well in advance (preferably a day prior confirmation) to avoid delays. A 15 min warning to pre-operative pt. Area/live tracking is recommended before cleaning the OT for the next case. Asst. Doctor / nurse in charge /HCA can check the next pt. And necessary parameters when closure begins and not waste time later.

To have a single agency for HCA and housekeeping staff to avoid interdependency and in turn avoid delays in TAT. Notification to be sent to patients prior to surgery and confirmation should be taken from them before final entry on the OT list. To notify a cleaning team during skin closure only. Information should be given in advance to the surgeon / anesthetist in charge of the case to avoid delays. Keeping track record of tat at nursing station and noting reasons for delayed TAT, live tracking the cases. In fact it was observed that OT 3 was inoperable for 7 working days and this was due to delay in repairs and maintenance. (Working on the maintenance is hence essential). Making Authentic OT LIST (only after booking charge is being paid and final confirmation from patients.) reducing cancellations. Efforts should be taken to utilize OT within the decided time frame of 8 am. To 6 pm. for its optimum utilization and doctors need to be informed about the same.

The requirement of the instruments/drugs/other equipment necessary for scheduled surgical list should be discussed among surgeon, staff nurse, and the anesthesiologist a day prior before final display of OT timetable.

CONCLUSION

Delay in starting lists, under-scheduling, interruption due to emergency surgeries, administrative reasons, induction of anesthesia and recovery policies are the foremost factors that account for unproductive use of operating facilities. Refining operating theatre efficiency leads to shorter waiting times for service, reserving elective operations and reducing canceled procedures. Most triggers of operation cancellation can be prevented, efforts should be made to prevent surgery cancellation by careful planning, taking into account the present resource constraints. To prevent under-or over-use of OT services, the OT list should be made carefully. Starting list delays, under-scheduling, postponement due to emergency surgery, managerial reasons, anesthesia induction and rehabilitation policies are the main factors that are the reason for unproductive use of operating facilities.

COMPLIANCE WITH ETHICAL STANDARDS

The above manuscript has received an ethical approval from IEC of Symbiosis International University (SIU) with no conflict of interest. Informed consent of the participants was taken

AUTHORSHIP CONTRIBUTIONS

Dr. Sanket Veling (Principal Author) - Conceptualization of study, Data collection, Data analysis, Writing of manuscript, Correspondence of article

Dr. Neha Ahire (Co-Author) - Conceptualization of study, Data analysis and validation, Final proof reading of article

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