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Original article

Operation theatre utilization: a prospective study

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ABSTRACT

INTRODUCTION: The operation theatre is one of the most expensive departments of any hospital. Operating time is money and it is to be emphasised that efficiency in the operating room is to be encouraged.

AIMS: To analyze the time utilization and to assess causes of delayed start, cancellations of scheduled cases and reasons for underutilization in OT complex of a tertiary care referral hospital.

MATERIAL AND METHODS: This is a prospective study of a descriptive manner carried out in month of March and April 2017. Each of the 9 OT tables were observed for 30 working days (270 days). The available resource hours were taken as (10am -7 pm), 9 hours per day or 270 hours in 30 days per table. The following parameters were noted –OT start time, OT finish time, Patient in time, Patient out time And a standardized turnover time.

RESULTS: The overall utilization of main OT complex of Jindal Institute of Hospital Sciences was found to be 77.14 % for the period of study, which is optimal as per standard literature.

CONCLUSION: Study of time utilization is a very important tool in assessing the optimal utilization of available resource hours in an OT and ultimately efficiency of an OT.

KEYWORDS: Operation Theatre, utilization

INTRODUCTION

The OT is a high cost department within hospitals. Considerable resources are wasted if OT is not utilized effectively. In any hospital, the OT is said to be the primary source of revenue generation with around 50-60% of revenue earned just by this department. It is therefore desirable to optimize the efficiency of this asset. Time utilization is a simple and adequate measure of the efficiency of the theatre. The classic definition of OT utilization is the sum of the time it takes to perform each surgical procedure (including preparation of the patient in OT, anaesthesia induction and emergence) plus the total turnover time, divided by the total time available for working. Operation room utilization analysis is essential to assess the existing workload as well as to optimize facility functioning and patient scheduling for surgical operations. It can also aid in allocating reserve time for emergency operations, asepsis measures and procedures, and provide decision making information for augmentation or downsizing of the facility. Strum et al defined the concepts - overutilization and underutilization. Underutilization is defined as time during the scheduled hours of operation that is not used, and overutilization is defined as the time used by scheduled cases past the end of the scheduled time. With these concepts we can estimate the economic efficiency of an operating room. To schedule more cases, either the schedule can be allowed to extend beyond the end of the day, or the expected duration of each case can be arbitrarily shortened and more cases squeezed into the allotted time. The ability to increase utilization, therefore, appears to be limited ultimately by the degree to which the schedule is

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allowed to extend beyond the end of day and by the delay that patients are asked to assume.[1-4]

Analyzing the operating room utilization trends allows rescheduling of elective operating sessions so that all units achieve optimal utilization. This is only possible if the data is closely monitored and if reasons for low utilization rates and/or high rate of unused sessions are investigated. Potential relationship with other indicators of performance to increase content validity of the set as a whole, forces hospitals to monitor operating room utilization.

According to Donham and colleagues, OT utilization is defined as the quotient of hours of OT time actually used during elective resource hours and the total number of elective resource hours available for use. Baker had opined that accurate records, weekly analysis of recorded data, establishment of operating rules and regulations, and strict adherence to and enforcement of approved policies and procedures are essential ingredients for efficient operating of operating room.[5]This project is being done in O.P. Jindal Institute of Medical Sciences, Hisar, Haryana. It is a multispecialty, tertiary care, referral hospital catering to a wide range of population. The hospital is spread across 14 acres, with 10 operating theatres apart from cardiac OT, 558 hospital beds and over 230 critical care beds. It caters to a population of 70 lac people of the region of Haryana, Punjab and adjoining Rajasthan. Presently, JIMS treats 4.5 Lac OPD, 45000 IPD and performs approx 16000 surgeries annually.

AIMS AND OBJECTIVES

1. To examine the utilization of OT in the main OT complex of hospitals in relation to work load
2. To see if there's any underutilization or overutilization
3. To identify bottleneck or cancellation, if any
4. Based on above, to suggest remedial measures for improvement

METHODOLOGY

This was carried out for a period of 30 days in months of March April 2017 in the main OT complex at O.P. Jindal Institute of Medical Sciences, Hisar, Haryana after taking due permission from hospital ethics committee. The total number of operation theatres are 9 excluding Ophthalmology and Cardiac Operation theatres. Surgical beds utilising main OT complex are around 250. Surgical bed OT ratio is almost 28:1.

The OT's are in pairs except Septic OT. There is a common pre anaesthetic room where patient is wheeled in for PAC before surgery and almost all patients have i/v access either from wards or PAC room. There is a common post anaesthetic room attached to main OT complex where patients are kept for observation and monitoring post-operatively for periods ranging from 30 minutes to 2 hours.The scheduled elective operation theatre timings are 10.00 am to 7.00 pm. The staff does 8 hours duty in 2 shifts. First shift from 08.30 am to 04.30 pm. Second shift from 11.00 am to 07.00 pm. Since most of the OT's are paired there is sharing of staff, equipment and instruments. Sometimes with availability of adjacent OT, overlapping in cases is also done. This is a prospective observational study. For data collection a performa was made and distributed to the respective OT Incharge's. The data was collected for 30 working days. The various stakeholders were anaesthetic team, surgeons, OT Incharge's/coordinators and OT nursing staff. They were made aware about methodology of data collection and it's relevance to the study.

Utilization index or coefficient u for OT is calculated as

$$U = N/M$$

where N is total number of hours the OT table can be used in the same period.

Available resource hours (OT time 10 am-7 pm) 9 hours/ day or 2430 hours/ 30 days.

Following parameters were recorded:

OT start time

OT finish time

Time spent on surgery table including anaesthesia induction and emergence time. (Patient in to patient out time)

OT turnover time (including OT resource utilization time). OT turnover time may vary in different theatres, here we have fixed it at 15 minutes. Also variations in workload on specific days due to seasonal variations (like crop harvesting or some local festival) and keeping in view of the under-utilization of a specific OT (Surgeon being on leave or a malfunctioning instrument). These points were also noticed. Reasons for cancellations or postponements were noted.

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View point of OT coordinators, CSSD incharge and ward coordinators was taken into consideration. Regarding OT start and close timings and workload, questionnaire was asked from the staff. Timings were noticed for all procedures, and all the under mentioned surgeries and situations were included in our calculation for operating time utilization. Major surgery, Minor surgery in anesthesia, MAC or Stand by, Procedures like Dialysis lines/ CVP's. Various Nerve Blocks for pain relief. Patients with delayed recovery from anaesthesia that had to be kept till emergence. Patients that needed to be shifted to ICU directly from OT table, waiting time.

RESULTS

Table 1 Demographic profile

Table no	Speciality	Total cases	Total operating hours'	Total turnover time	Total utilization in hours	Utilization percentage
1	General surgery	108	197	27	224	83
2	Oncosurgery	77	151	19.25	170	62
3	Urology/plastic	192	214	48	262	97
4	ENT	107	170	26.25	196.75	72.87
5	ENT	104	146	26	172	63.7
6	Gynae/Obst	160	173	40	213	78.88
7	Orthopaedic	116	202	29	231	85.5
8	Neurosurgery	86	191	21	212	78.5
9	Septic/emergency	134	163	33.5	196.5	72.8

OT1 is allocated to general surgery and Gastrointestinal surgery, divided on alternate day basis. Both major and minor surgeries are done in this OT. Major being laparoscopic surgeries including bariatric, lap esophagectomies, hernias, cholecystectomies, appendicectomies. Others are Whipple, open esophagectomies, lienorenal shunts. Minors include biopsies, sinuses, fistulas, ICD etc.

OT is ready to be started by 9.30 am but on average, starts around 10.15 am. Reason for this delay was also worked upon. The GI surgeon admits his patients on a day prior to surgery, gets pre anaesthetic checkup done and patients are prepared for OT the night before. OT complex opens at8.30 and most GI surgery patients are wheeled in by 9.00am. But in case of general surgery, most OT list is either TPA or Haryana government empanelled employees. Their package for surgery starts on day of admission, so they prefer to come same morning, so that their package doesn't exceed the allotted amount. Hence OT doesn't start on time.

Getting investigations and PAC workup after admission is sometimes not a smooth process. The pharmacy being internal for IPD patients, there is a great rush in mornings. This causes delay in the whole process and hence starting of OT.

Average OT close time is 5.30, which is reasonable, as the first staff shift gets over by 4.30. The OT ran beyond the scheduled hours on just 2 days. Total utilization of this OT came to 83% which is very good in comparison to established literature. During the course of this study, the general surgeon has tried to improve on his system. He's started admitting at least one patient the day before, and getting investigations and PAC done on day the patient walks into OPD for non empanelled patients. That way first case gets induced and started on time. For the empanelled patients, the hospital administrator was asked to prioritize a separate counter in the pharmacy for speedy dispensing of drugs, so the patient could be prepared well in time for shifting to OT.Operating room 2 is allotted to department of oncosurgery on a full time basis. Utilization rate of this OT was found to be relatively low as compared with other OT's. The established senior oncosurgeon resigned few months back and the new one joined 3 months back. There was a period in between when the hospital was without an oncosurgeon. This is indicated in low volume of patients in OPD and

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hence fewer surgeries, leading to this low rate. OT close time is exceeding beyond scheduled closing hours on some days.

OT 3 is shared between urologist and plastic surgeon. Three days each is allowed to the two departments. The hospital has a full time urologist, but two part time plastic surgeons.The urology list is always heavy and department has a good volume of patients. OT has dedicated staff and OT coordinator, like all other OT's, but due to better coordination between surgeon, OT and ward incharges, this particular OT starts earliest of all the operating rooms.

The close time is also around the scheduled closing time on most days barring two days. But taking into consideration the turnover time for all cases to be same that is 15 minutes, the total turnover time is 48 hours and the utilization exceeds way past optimal, at 97%.The plastic surgeon comes part time for few hours every alternate day to operate in this OT. His hours are limited between 11 am to 2 pm. Rest of the time, OT is utilized by the urologist to finish off pending cases from last day in morning or any new admissions the same day evening. The urologist keeps a good communication with the anaesthetist in charge regarding high risk cases and pre anesthetic work up. That way the list is finished off smoothly without much cancellations or postponement of cases.

There is hardly any wasted time in this particular operating room, which is reflected in an almost perfect utilization time of 97 %. OT 4 and 5, for all practical purpose, we consider it as a single operating room, since it has 2 dedicated ENT tables, and we calculate the utilization rate taking average of the 2 tables, which comes out to be 68.2%. This is an underutilized OT. Due to certain administrative pressures, if the surgeon is on leave, the OT tables go idle. They are not open for utilization by other departments.

This is otherwise a high volume OT, but since our senior surgeon was on academic leave for a week, the reason for less than optimal utilization rate. Many a cases being done under local anaesthesia, time for anaesthesia is greatly reduced. Operating room 6 is mainly gynaecology OT. Gynaecology, being an unpredictable branch, and there being a single operating room, sometimes lists don't go as planned. Although we have a separate OT for emergencies, but if that is occupied by some other surgeon, in case of an obstetric emergency, the routine list has to be interrupted.

The OT start time is 10.45 am. The senior most surgeon admits patient one day prior, so that patient is ready for OT next morning. But the junior surgeon admits patients morning of surgery. There being long lines at internal pharmacy, it takes more time in the mornings to get medicines, thus patient could not be prepared in time for OT. Hence, 3 days in a week, the OT starts late. The closing time for this OT is 6.10 on average. In case some emergency comes in between, scheduled list gets postponed or cancelled. In case another OT is free, the cases are posted there to get the scheduled list over. Overall utilization is optimal as per literature at 78.88%. But lot of effort and coordination goes into optimal running of this particular OT. Thus utilization rate touching almost 80% might be a slightly over inflated figure. But since in our study we are only taking into consideration, patient in and patient out time, this is a slight pitfall.

In OT 7, arthroplasties are performed, including TKR, THR, and arthroscopies, both knee and shoulder, and all kinds of simple and complex trauma are operated upon. There are3 orthopedic surgeons, one being a paediatric orthopedic. There is a mix of cases both in terms of variety of surgery and patient population in this OT. In orthopedics, lot of time goes into proper positioning and draping of the patient. But that is included in our estimation of utilization rates. Giving anesthesia is also challenging at times in this patient population, and might take more time as compared to other branches. Hence even at a lesser number of total surgeries, the utilization time is more than optimal at 85.5 %.

The OT starts early on most of the days, around 9.45 am. To save on time, sometimes spinals and blocks are given on other available operating rooms and shifted here after previous patient has been shifted out and OT cleaned up. Sometimes last case gets cancelled, if a case gets unexpectedly delayed due to any reason, which might be- unavailability of proper instrumentation after opening up, change of operative plan during the surgery, equipment or instrument malfunction. The reason for a good utilization rate is again a good coordination between OT and ward incharges, surgeon and incharges. Swift movement of patients to and fro ward and OT and PACU. This is one OT where there is a propensity for overutilization as

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the cases might get delayed. So we have put a cap for not taking up long cases after 5.30 pm.

There are two neurosurgeons both with a good volume of work but the OT timings are not well defined between the two, hence there is always confusion regarding who starts the OT. The OT shows a utilisation rate of 78.5%. Number of surgeries is less at 86 but all of these are major cases which last for longer periods of time, sometimes a single surgery lasting up to 5 - 6 hours.The average close time is 6:40 P.M. OT 9 is emergency cum septic operating room, and is shared between multiple specialities. These include all incision and drainage of any kind of abscesses, pyometras, osteomyelitis, wound debridement, burn dressings, open laprotomies, crush injuries etc

Most of the times there is confusion as to which department gets to use the OT when. There are no fixed slots, and the cases are taken up on either first cum first basis or depending on priority of emergency.

The OT start time on average is 10.35 am and close time 6.20pm. At a utilization rate of 72.8%,the overall utilization is optimal as compared with other literature. The OT is over-utilized on some days when there are more emergencies or septic cases, and some days underutilized. Many times there is a queuing of cases and the OT coordinator has to intelligently decide and plan priority wise.Hence it can be deduced that the main operation theatre complex at O.P. Jindal Institute Of Medical Sciences has a utilization rate of 77.13% average, which can be considered optimal as per standard literature.

OVERALL UTILIZATION OF OT's AT JIMS

The average utilization of 9 OT tables in main OT complex of JIMS is 77.14 %, which is optimal as regards the available literature from various studies.

TABLE 2
UTILIZATION % PER OT TABLE

OT 1	OT 2	OT 3	OT 4	OT 5	OT 6	OT 7	OT 8	OT 9
83%	62%	97%	73%	63%	79%	86%	78%	73%

TABLE 3
UTILIZATION OF OT IN HOURS PER DAY

1	2	3	4	5	6	7	8	9
7.3	5.35	8.45	6.30	5.45	7.00	7.45	7	6.30

According to our study,

OT 3 at 8.45 hours shows almost 100% utilization.

OT 1 and OT 7, at 7.30 and7.45 hours respectively show more than optimal levels of utilization.

OT 6, OT 8 and OT 9 at 7.00, 7.00 and 6.30 hours respectively show optimal levels of utilization.

Since OT 4 and OT 5 are twin tables,and their utilization is calculated collectively, this operating room and OT 2,at 6.07 and 5.35 hours respectively show less than optimal utilization.

TABLE 4:
OT start and finish times (average)

	1	2	3	4	5	6	7	8	9
START TIME	**10.15**	**11.15**	**9.45**	**11.20**	**11**	**10.35**	**9.45**	**11.20**	**10.35**
FINISH TIME	**5.30**	**5.30**	**6.30**	**4.40**	**6.00**	**6.10**	**6.45**	**6.40**	**6.20**

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Most common reasons for delay in starting OT

1 Patient being shifted to OT late from ward.
2 Surgeon coming to OT late.
3 In case of large number of unexpected emergencies the night before, there occurs shortage of linen and instruments the next day.
4 Sometimes if a pre anesthetic checkup was not done prior, the anesthetist may ask for a particular investigation or opinion, resulting in delay.

Most common reasons for late finish time

1 OT starting late in the morning.
2 A regular scheduled case gets extended beyond the projected timing for that particular surgery.
3 Equipment malfunction in between a case
4 Unscheduled surgeries squeezed in the scheduled list
5 Having to take up emergency surgeries in between regular list.

Most common reasons for cancellation or postponement of cases

1 OT running late already.
2 Patient gets PAC unfit.
3 Unavailability of OT

OT start time was recently preponed to 9.30 from 10 am. But closing time remained the same at 7pm.It's impact-

Nursing staff is happy when their shift gets over early, as they have more time to themselves.

Out of 5 OT coordinators,3 were satisfied with the change. 2 thought that their work increases once the 4.30 shift gets over.

Most surgeons and anaesthetists have been demanding this and satisfied with the change.

Our stakeholders in this study are anesthetists, surgeons, OT coordinators, nursing staff and OT technicians. On asking them about various measures to improve utilization in OT, the following responses came –

1. First patient to be wheeled in OT on time.
2. A proper work culture should be established in OT.
3. People should be made accountable for their actions.
4. Responsibility should be fixed for delays,whether it be doctors or staff.
5. Discipline and decorum of work place should be maintained.

DISCUSSION

The operation theatre is one of the most expensive departments of any hospital. Operating time is money and it is to be emphasised that efficiency in the operating room is to be encouraged. While going through the review of literature, there are very limited studies available showing utilization of operation theatre, from within the country. It might be due to lack of awareness or lack of infrastructure or maybe systems are not in place in most hospitals yet to measure the indicators of operation theatre efficiency.

Effective operation theatre utilization for every hospital should be calculated and all efforts must be made to reduce the number of idle theatre hours. Attainment of operation theatre utilization levels between 70-80% is considered realistic in most hospital settings. This figure is supported by various descriptive studies.

Jindal Institute of Medical Sciences being a high volume, multi specialty centre, we can't afford to let OT hours go waste. Earlier the OT's were starting by 10.30 to 11 am and elective lists were extending beyond usual closing time of 7 pm thereby resulting in cancellations of elective cases and hence over utilization of OT's.

But just few days before this study was conducted, staff duty timing was shifted to 8.30 am instead of 9 am. Hence most of the OT's were ready by 9.30 am - which resulted in earlier starting time in most OT's and better finish time also.There were 3 different patterns in various OT's. Oncosurgery and Neurosurgery have fewer but long cases. The turnover time for individual cases is longer than rest, but if calculated overall it is reasonable. Most of these patients are from and to HDU's and ICU's with a proper handover from staff to staff.

These OT's also showed a slight under utilization with the oncosurgeon being on leave for few days.

General Surgery and Gynae OT's have mainly scheduled surgeries but sometimes interrupted due to emergencies in between. The delays are mainly due to delay in shifting patients from wards- as instead of a single ward there are private rooms of various ranges to general ward and labour room in Obstetrics and Gynaecology.

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But still it was more or less acceptable and the OT coordinators are in touch with ward coordinators for the smooth shifting of patients. ENT OT has 2 tables and in most of the days with senior ENT surgeon operating turnover time was in fact found to be less than optimal and utilization is almost maximal.It can be inferred that the OT utilization in JIMS is optimal for this period except in oncosurgery OT where surgeon is relatively new with less workload and was on leave intermittently. But even that lacuna was filled up to an extent by providing OT to other surgeons who were in queue. Although it was not statistically taken into consideration in this study, but it was observed that start time of surgery from time of anaesthesia induction was more in certain OT's like Orthopaedics and Neurosurgery. But this is again due to more time taken in positioning, draping and overall surgical preparation of these cases.

The OT resource utilization time and cleaning times are relatively longer in these OT's as compared to other OT's. Computer simulations and mathematics models, from various studies, both of which are essentially idealisations, compute the practical capacity for operation theatres at between 80-90%. Utilization of 100% is referred to as the holy grail, because it is essentially sustainably unattainable owing to unavoidable variations in procedures and other factors at work.

It was also seen that even after full surgical list, the OT remained under-utilised sometimes Mainly it was because of the failure of the patients to show up in morning without informing or cancellation because of being unfit for anaesthesia. In comparison to a study in AIIMS in which there was almost 26% cancellation due to unrealistic scheduling and restrictions on time for giving general anaesthesia. Also the time taken for same surgery varied depending on skills of different surgeons, it being a teaching hospital.

In our OT complex, cancellation of cases is very low. We try to get most dated cases finished by evening. There is no fixed deadline regarding administering general anaesthesia. It depends on case to case and circumstances (which might be patient factors, surgeon factors or facility or administrative reasons in exceptional cases). Some cancellations or postponements were seen in ortho OT especially in summer season when operative lists are heavy.As found in a study in Philadelphia children hospital, since case duration cannot be predicted accurately in advance hence the scheduling of OT becomes a bit difficult. Hence predicting case time thus becomes a major factor if one wishes to achieve maximal utilization. Decreasing the variability in case times allows increased utilization to be achieved. As the variability of case time increases, it is more difficult to schedule times accurately and more difficult to achieve maximum utilization without making patients wait or having the schedule extend past end of the day.

There is a tendency to post longer cases early in the day and shorter cases later. But it was seen that it posed problem later in the day when first shift staff got over at 4.30 pm. So either these staff had to do overtime sometimes or the turnover time increased in later half of the day because of inadequate number of staff.

In our operation theatre complex, we try to strike a balance by trying to finish off shorter cases early, either by overlapping or utilizing the OT ‘s that start relatively late on that respective day.

The reasons for delayed start were found to be the same as a study done in AIIMS, but number of cancellations is much less in our set up, maybe because ours is a private setup. In a verbal communication with doctors and staff, the satisfaction levels are also much higher regarding working of main OT complex as compared to that in AIIMS.In a study conducted at AIIMS on utilization of operation room by Kumar et al, majority of the consultants and nurses felt that OT’s are starting late and the commonest reason stated was delay in shifting of patients from wards to OT. Non availability of staff or sterile supplies was an infrequent reason for the delay. Proposal regarding O.T.'s being run in two 8 hours shift elicited a favourable response, but they were apprehensive about their implementation, logistics, its impact on academic standards and the availability of the support services (ICU, labs, blood bank, CSSD/others) to handle the increased work load.[2] In another study conducted by Tyler et al, economic considerations suggest that it is desirable to keep operating rooms fully used when staffed, but the optimum utilization of an operating room (OR) is not known. They created a simulation of an OR to define optimum utilization.[3]

In comparison to Nizams Institute of Medical Sciences, which showed a utilization rate of 72.51%,ours at 77.13% is even better.[4] Hence,

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the present study conclude that after comparing with studies worldwide,[5-8] that main OT complex at Jindal Hospital, Hisar is functioning optimally, with further scope of improvement.

CONCLUSION

It can be concluded within the restraint of short span of this study, that operation theatre complex in Jindal hospital Hisar is being optimally utilized, in comparison to other studies conducted in various hospitals world over. Most of the surgical OTs show 70-75 % utilization, and ENT OT and orthopedic OT is being almost90% utilized, for the period of our study. By making OT end within scheduled hours, we are saving on overtime costs. Also repeatedly running OT late is hard on staff morale and makes recruiting and retaining already scarce staff more difficult. Using the concept of overutilization and under utilization allows us to put a cost to running late and to quantitate the quality of OT scheduling.The OT runs maximally from 11 am – 6 pm, which is the time when we have maximum resources at hand, whether it be availability of nursing staff, technicians or anaesthetists.Both surgeons as well as anaesthetists are overall satisfied with the running of OT. Start time and close time are predictable most of the days, unless some emergency comes or if an unforeseen event occurs, like equipment malfunction. But there being a separate OT for emergency, and shared equipment between OTs, these problems are also taken care of at the earliest. Also with 2 in-house biomedical engineers, equipment down time is very less. Hence Jindal being an established, reputed hospital, having good infrastructure in place, effective administrative staff, adequate resources available and standard policies and protocols, OTs are run smoothly and efficiently and to an optimal level of utilization.

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