

Audit of operation theater time utilization with perspective to optimize turnaround times and theater output

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Abstract

Background and Aims: Operation theater (OT) complex is an important area for a hospital as it needs expensive infrastructure, disposable, and reusable resources and a multidisciplinary highly qualified and efficient team, the metrics of which are key in generating revenue, and improved productivity. The efficient utilization of OT ensures maximum output in view of the investment of highly qualified doctors, equipment, and outcomes. Our study aimed to evaluate the utilization of OT functioning stepwise, reasons for delays, case cancellations, and areas of improvement if any.

Material and Methods: This prospective observational study was planned in three phases; in phase 1 audit of OT functioning was carried out for 1 month and based on data analysis recommendations were given for improvement. In phase 2, the recommendations would be implemented over 3 months and in phase 3 re-audit will be carried out for 1 month. Data analysis was done on IBM SPSS version 26 software. Descriptive statistics measures were calculated by the mean and standard deviation.

Results: The total available resource time was 52920 min and the total time utilized was 37740 min. Overall, raw utilization was 71.31%. OT was started late 63.50% times. Case cancellation occurred on 8.99% occasions.

Conclusion: We conclude that utilization of operating room time can be maximized by proper planning and realistic scheduling of elective lists, communication among team members, and resource management. Audit of OT utilization is an important tool to identify problem areas and formulate protocols accordingly.

Keywords: Audit, data analysis, operation theater, productivity

Introduction

Operation theater (OT) complex is one of the most important areas of any hospital as it contributes to most of the expenditure, workload as well as revenue.^[1,2] On an average, OT cater to 50% of the needs of total health-care seekers.^[3] Maximum utilization of OT time results in high-cost benefits, fewer case cancellations, reduced waiting list, improved patient satisfaction, disciplined staff, and growth of the institute.^[4-6] For a tertiary care teaching hospital, especially one in the evolving phase, performing an audit of OT functioning helps to identify areas of improvement for efficient utilization

of theatre time.^[5,6] We conducted a prospective audit of OT time utilization with aim to evaluate the OT functioning, stepwise reasons for delays, case cancellations, and areas of improvement if any.

Material and Methods

After receiving approval of the Institutional Ethical Committee (ESICMC/SNR/IEC- F0149/11-2019), this prospective audit was planned in three phases. The audit trial was registered under Clinical Trial Registry

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India (CTRI/2020/03/024126). In phase 1, data collection and analysis of data regarding OT functioning was done for 1 month and based on the findings, recommendations were given for improvement. The data analysis and recommendations were explained to all the theater staff in the form of lectures and PowerPoint presentation of results. The plan for phase 2 was to implement the derived recommendations over 3 months. In phase 3 re-audit for one month, to assess any change in output was planned. Because of current COVID pandemic elective surgeries were postponed and we were unable to implement phases 2 and 3. As the elective list is resumed now we are in phase 2 of implementation of driven recommendation. Phase 1 was carried out for 1 month from 1st December 2019 to 31st December 2019. All the OT complex staffs were informed about the audit by e-mail, message, and a notice on the OT notice board. Our institute is a tertiary care teaching institute established only 4 years ago, having 475 beds. The OT complexes have eight functional operating rooms (ORs) on the two floors, of which 6 were considered for the audit. Ophthalmology and minor OR were not included in the study. Working hours for routine scheduled cases were from 9.00 am to 4.00 pm on all working days except Saturdays (9.00 am – 1.00 pm), Sundays, and public holidays. Gynecology OR was used for plastic surgery on Tuesdays and ENT OR on Fridays. Following parameters were observed and times noted for each patient

- OT start time: the time when the first case was wheeled inside OR, any delay after 9.15 am reasons were noted
- Wheel in time: for each patient the time when a patient was wheeled inside OR
- Induction time: the time from when anesthesiologist attach the first monitor to time when the patient is handed over to surgeons, any delay > 10 min and reasons were noted
- Position and preparation: the time for positioning the patient for surgery and painting – draping
- Surgical time: the time from first skin incision to dressing
- Emergence time: time from dressing to when the patient would be ready to wheel out, any delay > 10 min and the reason was noted
- Cleaning time: time for cleaning the OR in between cases
- Estimated time for surgery as given in the surgical list
- Turnover time: time difference between wheel out and wheel in of patients
- Overruns: which extended beyond 4.00 pm and causes for overrunning
- Reasons for case cancellation and rescheduling were noted
- OR utilization time: the time that patients were in the OT
- Overall raw utilization time: total hours of cases performed within the OT time (all OR) divided by the total hours of allocated time (all OR).

Raw utilization for each OR = Total time utilized/total resource time available $\times 100$ ^[7,8]

The data were collected in proforma by Senior Resident of respective OR.

Statistical analysis

Master chart of all data was made in Microsoft Excel. Data analysis was done on IBM SPSS version 26 software. Descriptive statistics measures were calculated by the mean and standard deviation. For nominal variables frequency and percentage were calculated to summarize data.

Results

Each OR under study functioned for 21 working days (21 \times 6 = 126 working days). The total available resource time was 52920 min and the total time utilized was 37740 min. Overall, raw utilization was 71.31% [Table 1].

OT was started late i.e., after 9.15 am for 63.50% times. The average OR start time was 9.28 \pm 0.31 am. The reasons for the delay in starting theatre are highlighted in Table 2.

A total of 32 cases (8.99%) were cancelled from planned elective lists. The reasons for case cancellations were as in Table 3.

Table 1: OR-wise time spent on different steps in minutes (mean \pm standard deviation)

	Average OR start time (AM)	Turnover time (average)	Overruns (average)	Total no of cases	Resource time available	Total time utilized	Raw utilization %
OBG	9.32 \pm 0.38		12.50	65	8820	3845	43.60
Gen SX	9.14 \pm 0.15	14.55	24.27	83	8820	7127	85.34
Gyn	9.13 \pm 0.05	16.80	80.00	31	6720	5499	81.83
ENT	9.35 \pm 0.49	12.65	12.50	46	7140	4075	57.07
Ortho	9.37 \pm 0.30	17.48	40.71	44	8820	6381	72.35
Ortho	9.37 \pm 0.51	9.47	48.33	36	8820	5766	65.37
Plastic	9.29 \pm 0.12	11.45	62.50	19	3780	2565	67.85
Total	9.28	13.73	35.95	324	52920	35258+2482*=37740	71.31

*Time utilized for general surgery cases in other OR

Induction time was prolonged only for 4.94% of the total 324 cases observed. The reasons for the induction delay were as in Table 4.

OT overrun was observed 29 times (23.01%) of a total of 126 elective lists. Most of the overruns were in general surgery followed by orthopedic OR. The average overrun was 35.95 minutes. OR-wise average overrun was as in Table 1.

Turnover time on average was 13.73 min during which the cleaning and preparation of the next case were done. Turnover time was longest for C-arm operated orthopedic OR i.e., 17.48 min as time were taken to arrange the fracture table according to patient.

Table 2: OR start delay reasons

Reasons	Total no	Percentage
Patient not shifted from ward	8	10
Patient not optimized	4	5
Consent not taken	7	8.75
Trolley for wheel in not available	5	6.25
Implants not available	5	6.25
Surgeon reporting late	43	53.75
C-arm not working	1	1.25
Laparoscopy instruments not available	4	5
No water	1	1.25
No spinal set	1	1.25
Staff not available to wheel in trolley	2	2.5
Total	80	100

Table 3: Reasons for case cancellations

Reasons	Total	Percentage
OT time not available	6	18.75
Surgeon preference	7	21.87
PACU bed not available	1	3.12
Difficult spine	1	3.12
Patient not admitted	3	9.37
Emergency case added	3	9.37
Patient not optimized	6	18.75
Lap instrument not available	2	6.25
Patient not willing	3	9.37
Total	32	

Table 4: Reasons for induction delay

Reasons	No	Percentage
Difficult spine/airway	4	25
Trainee	3	18.75
PNB	2	12.5
Complications	2	12.5
Invasive line/EA	2	12.5
USG machine NA	1	6.25
Waiting for surgeon	1	6.25
Patient not optimized	1	6.25
Total	16	

Discussion

There is growing interest in efficient utilization of health-care resources and one such area in any hospital is OT complex.^[9] The efficient utilization of the OT complex needs a well-coordinated team, working equipment, steady supply of drugs, consistent and timely Central sterile services department (CSSD) services. Several performance parameters relevant to OR utilization have been identified.^[10,11] We studied patient flow through each step from OR to the postoperative ward.

In our study OR was started late on 63.02% times. Total of 1661 minutes (approximately 4 working days) accounting to 3.14% of available resource time were lost due to late starting of OR. This is comparable to a similar incidence of 43.6% times as seen in a previous study by Vinukondaiah *et al.*^[4] The most common reasons we found related to the human resources were – surgeon reporting late followed by staff unavailability for patient transit and administrative reasons like inadequate number of trolleys, patient not shifted from ward to preoperative area on time, consent not available, instruments/implants not readied among others. All of these delays were avoidable as shown by Naik and colleagues in their study.^[5]

Ranganathan *et al.* in their audit of OR utilization in tertiary care cancer center showed that the median time of starting the OR list was 5 min after the scheduled list start time, with 15% first cases entering the OR more than 10 min late.^[12]

In our study, case cancellations were 32 (8.99%) which is keeping with published literature. Senior surgeon unavailability was the most common reason for cancellation. Other reasons included non-availability of OR time, patient no show, patient not willing for surgery or not optimized which could be corrected with proper OT list scheduling and patient counseling. On three occasions, cancellations were due to emergency cases done during the elective hours. Two cases cancelled due to miscommunication regarding sharing of laparoscopy instruments between surgical teams. Talati *et al.* analyzed OR time utilization and case cancellations in a tertiary care teaching center where 22.5% of scheduled cases were cancelled with lack of operating time being cited as the main culprit.^[13] Naik and colleagues found 10.54% of scheduled elective cases were cancelled with similar reasons as in our study.^[5] Another prospective study observed case cancellations were not only a scheduling problem but were due to surgeons underestimating the surgery time.^[14]

In our audit, induction was delayed by more than 10 min on 16 occasions (4.99%) of 324 procedures with a difficult

spine or airway being the commonest reason. Postgraduates performing the procedure, peripheral nerve block (PNB) being administered inside the same OR, invasive lines insertion, complications during induction were other causes. Induction times were longest in plastic surgery (12.89 ± 8.56 min) for maxillofacial surgeries with anticipated difficult airway. Orthopedic surgeries under C-arm guidance came a close second (11.02 ± 7.43 min) as patient positioning required constant attention to minute details.

Moreover, not only the type of anesthesia but tableside teaching of students, performance experience of individual anesthesiologists and equipment or assistant-related shortages also influence induction times.^[15,16] General anesthesia with SGA/tracheal intubation, securing of invasive lines, PNBs all add onto the lengthening of induction time necessitating proper planning and meticulous utilization of quality OR time.^[15,17,18]

The time taken for positioning and skin preparation was highest in orthopedic OR (14.34 ± 7.08 min) as patients needed to be positioned specifically on the fracture table followed by scrupulous scrubbing, painting, and painstaking sterile draping, all required for a total aseptic exercise. Obstetric OR had the shortest time for positioning and preparation (3.77 ± 1.39 min). Similar times were also quoted by Mazzei.^[19]

The total actual surgical time was 35434 min which accounted for 66.96% of available resource time [Table 5], with large inter- and intra-specialty variations depending on the operating surgeon and assisting personnel's experience. Previous studies have recorded timings ranging from 413 min to 631 min of operating time/day, approximating 90% of total available operating time.^[4,13] Jan *et al.* in their research done in a teaching hospital recorded that the time spent on actual surgery was 66.02% of available resource time, followed by 21% on supportive services and 12.9% on room preparations.^[20]

We also studied emergence time from general anesthesia. 33.02% cases were done under general anesthesia. Emergence time was delayed more than 10 min on five occasions; on two occasions laryngospasm occurred after extubation. For two

cases PNB was given for post-operative analgesia leading to delay in emergence according to our definition.

In our study, average cleaning time was 8.67 min per procedure which was within acceptable limits. In a retrospective study on utilization of OTs by Krishna, the reported cleaning time was between 10 and 17 min.^[9]

Transfer of patients from OR to postoperative care unit was delayed by more than 10 min on seven occasions i.e., 2.16% of total 324 procedures due to non-availability of shifting trolley.

Not surprisingly, the time estimates provided by the surgeon, that is 24534 min, fell drastically short from the actual surgical time of 35424 min, with no consideration for time for anesthesia and supportive care, resulting in overruns and case cancellations.

In our study, total OR utilization time was 37740 min accounting for 71.31% utilization of available resource time. Of the total time utilized only 2700 min i.e., 6.96% of resource time was spent on anesthesia induction and recovery which are as important as surgical procedure itself. Utilizing this time for surgery needs separate room for anesthesia induction and recovery with the need for the additional qualified anesthesiologist, monitoring equipment, supportive staff, and safety of patients during transfers between induction room and operating OR. Having the preinduction room can help for PNB procedure and invasive lines and also patient safety is not compromised. OR-wise raw utilization is as in [Table 1]. General surgery OR raw utilization was highest i.e., 85.34% also general surgery cases were accommodated in other OR accounting to extra 2482 min and 108.95% raw utilization. Economic considerations suggest that it is desirable to keep ORs fully used when staffed, but the optimum utilization of an OR is not known. A utilization of 85–90% is the highest that can be achieved without delay or running late, higher than this leads to patient delays and staff overtime. Increased efficiency of an OR comes at a cost of patient convenience.^[21]

Turnover time was utilized for cleaning theatres in between two cases and setting up of instruments and table preparation.

Table 5: OR-wise time spent on different steps in minutes (mean±standard deviation)

OR/time	Induction time	Position and preparation	Surgical time	Emergence time	Cleaning time	Estimated time
Obs	4.83±1.28	3.77±1.39	42.82	Neuraxial block	6.98±2.94	47.17±8.55
Gen SX	6.90±4.75	10.14±5.76	89.52±47.75	8.45±6.02	6.27±2.14	88.96±49.73
Gyn	11.07±5.19	7.41±6.51	108.97±78.94	8.5±4.58	5.87±1.96	89.23±48.90
ENT	8.95±2.76	5.58±4.15	57.46±30.47	9.51±5.32	8.42±2.31	71.44±32.04
Ortho (C-ARM)	11.02±7.43	14.34±7.08	103.07±59.42	6.33±2.29	8.18±2.16	90.57±40.67
Ortho	8.66±4.71	11.97±8.46	128.48±52.23	5.33±2.21	9.44±19.66	94.71±35.79
Plastic	12.89±8.56	8.39±8.23	102.33±57.14	9.36±5.16	7.22±3.08	93.33±52.41

In our study, the average turnover time was 13.73 min falling into the high-performance category according to Macairo categorization for turnover time.^[22] Kumar and Malhotra reported an average turnover time of 15.5 ± 7.26 min and 17.36 ± 11.53 min in surgery and orthopedic OR, respectively.^[23] Turnover time also depended on patient's ASA status, preceding surgery, succeeding surgery, time of surgery, and order of OR cases.^[24]

In our study, overrun occurred on 29 times (23%) of 126 working days. The average overrun time was 35.95 min. Realistic planning and meticulous scheduling of the elective list could minimize overruns but not eliminate it. OR overruns reduce OR personnel participation as it is not incentivized and hence an administrative trouble.

Based on observations from audit data the following recommendations were formulated

- All OR personnel to be available by 9.00 am.
- The first patient on the list to be in the preoperative ward by 8.30 am.
- Invasive lines and PNBs to be done in designated pre induction room.
- Special equipments needed to be intimated within the list itself and reconfirmed by 8.30 am.
- Availability of postoperative beds to be confirmed during the planning of the OT list and a new facility to accommodate increasing number of cases was identified.
- Clear communication among team members for laparoscopy and other shared equipment/instruments.
- Patient's fitness for surgery to be reviewed night prior.
- Standby optimized cases to be kept prepared in case of sudden case cancellations.
- For case overruns, incentives in the form of extra offs or extra staff for two shifts to be deputized.

The present audit was carried out for 1 month so results are bound to be different according to seasonal variations, festive months. The possibility of the Hawthorne effect cannot be denied as all personnel were aware of the audit being carried out.

The present audit was carried out in month of December 2019 before declaration of COVID-19 pandemic. Considering effect of pandemic on surgical practice the theater time utilization is bound to change once elective surgeries will be resumed taking in account increased waiting list, personnel availability commensurate with increased OR volume and resource availability. The audit will help in planning patient flow through different stages and additional time required for personal protective equipment donning, doffing, anesthesia induction, and recovery as well scheduling of OT list accordingly.

Conclusion

We conclude that utilization of OR time can be maximized by considerate planning and realistic scheduling of elective lists, communication among team members, and meticulous resource management. In our study, reasons for OR start delays, case cancellations, and overruns were multifactorial but largely avoidable. Audit of OT utilization is an important tool to identify key problem areas and formulate protocols accordingly.

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Conflicts of interest

There are no conflicts of interest.

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