



St. Paul's Hospital Millennium Medical College
Graduate study Program

Operation Theatre Utilization in a tertiary Hospital

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Addis Ababa, Ethiopia

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**Operation Theatre Utilization & Efficiency: A cross sectional
prospective study from a tertiary Hospital in Ethiopia**

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Abstract

Background: Operation Theatre is one of the most expensive facility within the hospital, which demands more than one third of the total hospital budget. Under-utilization of operating theatre has been a significant problem both for surgeons and hospital administrators, and causes significant negative impact for patient's satisfaction. In developing countries, where resources are limited, inefficient utilization of operating theatre is a significant problem, where only few studies have been reported.

Objective: The aim of this study is to assess the utilization and efficiency of operating theatre in surgery and gynecology departments at St. Paul's Hospital Millennium Medical College from June to September 2022.

Methods: A cross-sectional study was carried out by taking all complete and documented records of patients who have undergone elective surgical procedures in specific departments/units within the study period at St. Paul's Hospital Millennium Medical College. A checklist prepared in English language used to collect data. The collected data entered into a computer using Statistical Package for Social Sciences version 25.0 for windows. Means, standard deviations and percentages will be calculated. Moreover, relationship measures between variables was assessed using Chi-square. In the meantime, statistical significance was accepted at P-value < 0.05. The results are presented by the use of charts, tables, and texts

Results: A total of 822 elective procedures were scheduled, amongst 747 (90.9%) cases were operated averaging around 2.5 cases per table per day. Among 144,480 working minutes available for elective surgery, 128,766 minutes was used, averaging 427.7 ± 139 minutes per operating room in a given day. There were 75 cancellations, making cancellation rate to be 9.12%. The commonest reason for cancellation being lack of OR time (46.7%), medical reasons which make them unfit for the surgery (28%) and lack of operating materials & facilities (10%). The mean Start time, turnover and finishing time was 8: 02A.M $\pm$ 0:24, 0:22 $\pm$ 26 minutes & 2:59P.M $\pm$ 2:17 respectively. Delayed turnover time was seen in 21.9%, with 43 ± 26 minutes. The total utilization rate of was calculated to be 89.11%, ranging from 70.93% to 102.5%.

Overall efficiency rate was 75.6%, ranging from 60.3% to 84.4%. Operating rooms were underutilized in 42.7% while overutilization was found in 14.6%.

Conclusion and Recommendation: There was high rate of cancellation rates and higher proportion of overrunning times in the study. There was better utilization rates and slightly lower efficiency rates from the acceptable standards, which were having statistically significant relations with early finishes, overrunning times and number of surgeries performed in a day. Improvements in proper utilization of available OR times to avoid early finishes, minimizing the overrunning hours is recommended to increase the efficiency rate of our OR performance.

Keywords: Operating room, Operating Theatre, Utilization, Efficiency Rate, turnover time, Operating room Delays, Cancellation Rate

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Acronyms and Abbreviations

AaBET Hospital: Addis Ababa Burn, Emergency and Trauma Hospital

CVTS: Cardiovascular and thoracic surgery

GynObs: Gynecology and Obstetrics

HPB: Hepatopancreaticobiliary

IRB: Institutional Review Board

OR: Operating Room

OT: Operation Theatre

SPHMMC: St. Paul's Hospital Millennium Medical College

Introduction

Background

Operation Theaters are one of the most expensive facilities within the hospital, which demands more than one third of the total hospital budget. It also accounts for the majority of the hospital's revenue, around 40% and around 33% of the total inpatient cost was from the OTs, representing one of the highest expenses. This indicates that an efficient utilization of the operating theatre by all stake holders is of paramount importance ^(1, 2).

It is important to follow timeliness of operating room planning processes and strict adherence to scheduled times to achieve an effective and efficient utilization of operating rooms. OR processing times with greater impact to the overall efficiency includes; operation start time, turn-over times between cases, duration of surgery and finishing time of the scheduled cases ⁽³⁾.

Delays in different times of operating theatre process of undergoing surgery can cause delay in the subsequent scheduled cases which forces prolonged fasting to patients, frustrations to patient's relatives, extensions of working hours for the OT staffs, which in turn results in stress and arguments among the staffs, also increasing unplanned costs for the institution. Delaying first case of the schedule definitely delay the subsequent surgeries, which might lead to cancellation of some of scheduled patient, adding negative effects both on the patients and the hospital. Delays and subsequent cancellations in operating theatre is considered as one measure of quality of the hospital services and of course cause of resource wastage. On the other hand, under-utilization of OT is also one of the measures to assess efficiency of OT and has significant consequences on wastage of hospital's resources and indirect effect on surgical waiting lists ⁽⁴⁾.

Sub-optimal usage of operating time is one of the leading causes of cancellation on the day of intended surgery, accounting for 10% - 40% of cancellations where 60% being potentially avoidable. This results have significant negative impact on the quality of health care and social, psychological and economic burden on the patient and family as well, also results in losing of training opportunities for surgical trainees ^(4, 5).

Statement of the problem

Under-utilization of OT has been a significant problem both for surgeons and hospital administrators. Theatre utilization broadly tells us successful surgical admissions and operated on elective basis. Even-though unspecific, at extreme values it might show administrative process failure ⁽⁶⁾. Though a lot of factors can contribute to this problem, majority are assumed to be related to delays in different predefined 'OT times'. Lack of operating times has been reported the main reason of cancellation of elective schedules which may be a direct consequence of delay in transferring the patient throughout the process of the operation. Even though there's no single parameter to assess the effective utilization of an OR, most agree OT efficiency rate to be a better predictor.

Under-utilization has been reported in from many studies across the world, ranging from 60% - 100%. Some centers and some surgical units within a given center has also reported over-utilization rates that range from 100% - 174%, without considering the physical, psychological and financial burdens of Over-runs.

Delayed first case starts, delays in turn over times, early and late finishes are well recognized problems leading to sub-optimal usage of OTs in both developed and developing nations. These are also potential components of the process of elective surgeries where there is a potential room for improvement ⁽⁷⁻¹⁰⁾.

Significance of the Study

Despite the well agreed consensus that proper utilization of available time in an operating theatre leads to maximal efficiency and avoids drastic consequences for all involved stake holders; patients, families and hospitals, there's less data to describe the practice in these part of the world. Cancellations of scheduled patients and sub-optimal usage of available operation hours will add to prolonged queue to the existed long surgical waiting lists, affecting negatively both the individual patient's satisfaction and perceived quality of service providing institution.

Considering the fact that we are living in a very resource limited part of the world where by majority of the equipment and consumables are either bought with high

foreign currencies or found by donations, efficient utilization of hospital services including the operation theatre is of paramount importance.

To date there are only few publications in similar setup with limited description of the relevant factors ^(17,18). This study will focus on the assessment of the current practice of operation theatre and will try to identify the delays in the process of operating scheduled patients. It will also try to identify factors that influences the efficiency of OT and will forward recommendations towards better usage. In addition, the study will serve as a base for future studies to be conducted on related topics within and outside the country.

Literature Review

Sub-optimal utilization of OT is a well known problem which draws a lot of attention to OT working staffs and hospital administrators and it was present in surgical and anesthesia journals since the 1970s. OT utilization can be measured by different parameters, including efficiency, cancellation rate, under-utilization times, overrun hours & others.

An efficiency rate of an OR can range from 0% to 100%, with an ideal value of 100%. An efficiency rate of 80% should be considered as the minimum rate that should be attained and >90% is highly desirable to achieve ⁽⁷⁻⁹⁾. This parameter of measuring OT utilization is rational and considers balanced measures. However, different formulas might have been used in other studies. There are no data regarding to OT efficiency in the literature from Ethiopian or African studies, European studies show an efficiency rates of varying levels: starting from 68% - 90%, which is close to acceptable levels ^(7, 8, 10).

Another parameter to assess the OT efficiency or utilization is to equating the utilization rate. It is an important measure to determine how much of the available hours for elective surgeries have been optimally utilized. It is dependent on several factors, as OT efficiency, which can be all separately measured and considered as focus of improvement towards achieving better utilization and efficiency rates ⁽¹⁰⁾. Utilization is considered as a principal measure of OT performance ⁽¹¹⁾. Generally, an OT utilization rate of 80% is considered as optimal and reasonable. However, its drawback is that it doesn't consider over-run hours in to account, unlike that of the OT efficiency, there by resulting even in >100% utilization rates.

Western European studies have shown a higher utilization rates of 86% - 110% from United Kingdom which were associated with a proportional decrement in cancellation rates of elective scheduled cases from specific institutions, even though the efficiency of those institution failed to show significant differences. Older reports from United Kingdom show relatively lower rates of OT utilization, 68.2%-73.2% and 77.1%. This might be due to the attention given towards improving the effective use of operating rooms through the years ^(7, 8, 11, 12). Another study from the Netherlands done in two different set-ups reported a utilization rates of 70% - 80%, which is a slightly lower

from the ideal target rates ⁽¹³⁾. An audit from Orthopedic elective schedules from Australia showed OT utilization rate of 81% ⁽¹⁴⁾.

A higher rate of utilization was reported from India with 77% - 102% but failed to demonstrate similar efficiency rates. A very lower utilization rate was seen from the South African study, 55.2% ^(15, 16, 20). A wide range of variation was reported from our country, where two studies reported the utilization of black Lion Hospital done in different times. 10.5% - 174% (mean OT utilization rate unreported) from one study and 15.6% - 133.2%, with an average utilization of 72% from the other studies, even though both of the studies failed to report the efficiency of the OT during their respective time of study ^(17, 18).

The time of the first patient entering to the OR is considered to be the start time by majority of the authors and any delays might result in inefficient utilization of OT. A study from the UK showed a total proportion of time delays until the start of the first case accounts 3.1% the available time ⁽¹²⁾. A relatively acceptable delay in starting of elective procedures was noted with average time of 19 minutes, in Australia, with the total time spent by delays without starting first cases accounting for about 4% of the available time. ⁽¹⁴⁾. An Indian audit of OT utilization reported a delay has occur in around half of all the first cases, 43.6% ⁽¹⁵⁾. Another study from South Africa showed even a higher amount of lost time due to late starts, where it constitutes about 9.3% of available time with a very poor utilization rate of 55.2%, with an average start time delayed by 47 ± 31 minutes where 74% of the first surgeries commence after significant delay ⁽¹⁶⁾. Studies from another tertiary care set up from Ethiopia also revealed delayed start times, where operations are expected to begin at 8: 00A.M, procedures were seen to begin at an average times of $8:56 \pm 42$ minute and $8:43 \pm 31$ minutes, with delays in start time was noted in almost all first cases 93.4% and 97.5% of elective days ^(17, 18).

Early and late finishes of a schedule have been differently defined by several authors regarding the time delays. However, most agree that it's one of the main causes of poor efficiency and under-utilization of an OT. It was find to be a common problem in running of elective procedures in most of the studies. A study from UK has compared these factors in two hospitals with the first hospital having a low rate of early finishes, 1.3%, while having relatively higher rate of late finishes, at 31.6%, while the other hospital having a reverse pattern with 38.9% and 4.5% early and late finishes respectively. Both centers having a comparable efficiency at 84% and 80%,

possibly due to higher early finishes in one center and higher late finishes in the other. But the utilization rate was almost 100% in the center where there was a 31.6% of late finishes, utilization rate being 86% in the other center ⁽⁸⁾. Studies from similar part of the world showed variable rates of these parameters: ranging 14.8% - 25% of early finishes and 13.5% - 50% of late finishes ^(7, 12, 13).

Similar studies from India and South Africa have an early finish rates of 29% and 46.1% and late finish rate around 11%, whereas in Black Lion Hospital, Ethiopia relatively higher proportion of early finishes was observed at 47.9% and 27.8% of late finishes ⁽¹⁵⁻¹⁷⁾.

Another most important cause for poor utilization of OT is delays that occur in turnover time, a time from the exit of finished case until the next case to enter the room where time is used for clearing the room and getting ready for next patient. A study from the UK has reported around 5% of available OR time with utilization rate of 77.1%. Variable duration has been reported, ranging from 13 - 34.5 minutes, which accounted for 7% - 14% of the total available time and significant differences in utilization rates ^(14, 16, 19, 20). In an Ethiopian study where an average acceptable turnover time is considered to be 25 minutes' significant delay has been reported at 25 ± 49 minutes and 25.2 ± 31 minutes, where in one of the studies delayed turn overs account for 34.5% of available time ^(17, 18).

Cancellation rate can be one of the devastating effects of OT under-utilization and poor efficiency, which is associated with frustrations of the surgeon and anesthesia team, patient dissatisfaction and resource waste to the institute at large. An ideal cancellation rate is 0%, but in real time it's far from achievable, due to different reasons; generally categorized as potentially avoidable and non-avoidable. A minimum acceptable cancellation rate is considered when it 2% - 5% ⁽¹⁰⁾.

Cancellation rate of 1.1% - 23% has been reported from European studies, where higher rate is from 1990s ^(6, 7, 11). Indian studies also reported a wide range of cancellation rates ranging 0.6% - 27.8%, where lack of time accounted for around 60% of reasons for the cancellation ^(15, 19, 20). Higher rate of cancellation has also been reported from South Africa, 26.2% with 40.5% of cancellation reported to be caused due to lack of operating time ⁽¹⁶⁾. Ethiopian Studies has also reported significantly higher rates of cancellation where majority of the reason being shortage of operating time, 23% - 35% and around 33% respectively ^(3, 17, 18).

Objectives

General Objective

To assess the utilization and efficiency of operation theatre and factors affecting it, in different surgical units and Gyn/Obs department of SPHMMC

Specific Objectives

To determine the utilization rate of operating theatre

To determine the efficiency of operating theatre

To identify factors influencing utilization and efficiency of operating theatre

Describe effects of inefficient operation theatre utilization on cancellation

Methods

Study Setting

The study was conducted at St. Paul's Hospital Millennium Medical college (SPHMMC), Addis Ababa, Ethiopia. It is one of the largest tertiary care centers in the country with over 850 bed capacity. Surgical procedures are done in three different ORs, at main building of the hospital where surgery and gynecology departments operate, another building where ENT, ophthalmology and MFO surgery departments work and the last is at AaBET hospital wherein Neurosurgery, Orthopedics and Plastic surgery departments work. This study will be done at the main building of the SPHMMC, which is composed of 6 operation tables, 5 for elective surgeries and another OR table dedicated for emergency procedures. The hospital has an overall bed of around 100 beds, due to some arrangements due to the COVID outbreak. There are 40 beds for surgery (where HPB, CVTS, urology and general surgery utilizes) and gynecology, and additional 20 beds for pediatric surgery. Elective surgeries are performed from Monday to Friday starting at 8pm and ending at 4pm, by two departments; Surgery and GynObs, and different specialties of surgery; Pediatric Surgery, urology, CVTS, and HPB surgery.

Study Period

The study was conducted from Sene 1 to Nehase 30, 2014 E.C.

Study Design

A cross-sectional study design was applied to collect data during the study period.

Study Population

The study population of this particular study was every elective procedure scheduled under the departments of surgery and GynObs within the specified study period.

Exclusion Criteria: there is no specific exclusion criteria.

Sample Size

To achieve the maximum sample population, we will use the prevalence of each problem to be 0.5 and 95% confidence interval with margin of error 5%.

$$N = \frac{z^2}{d^2} * p (1-p), Z=1.96, P=0.5, \& d=0.05$$

$$N = \frac{1.96^2}{0.05^2} * 0.5 (1-0.5)$$

$$N = 384$$

Sampling Procedures

All procedures scheduled within the specified period of study will be included in the study by applying a take all sampling method.

Measurement

Study Variables

Dependent Variables:

- OT efficiency rate
- OT utilization rate
- Cancellation Rate

Independent Variables

- Start times
- Anesthesia Induction Times
- Incision time of first case of the day
- Number of Surgery
- Finishing Time
- Table turnover time.

Instruments

A structured data collection questionnaire was prepared to collect relevant information including date & day of the surgery, number of surgeries done in a given table per day, start time, anesthesia induction time, incision & finishing time of every procedure as well as reasons for delays and cancellations if there are any. This structured checklist was prepared from previous studies with some modification to fit the study set up.

Data Collection and Procedures

Data was collected from June to September 2022 G.C. A structured data collection questionnaire prepared in English language based on previous studies reviewed for this study. Peri-operative records from the daily OR schedules, OR checklists, Intra-operative anesthesia checklists and recovery follow-up charts were used to collect relevant data. Training was given to data collectors, on how to collect data and enter to computer. Records of the study population were assessed for completeness before data entry.

Operational Definitions

- **Start time:** the time the first patient of the day entered the OR
 - *Late start is defined as those OR entries delayed for more than 15 minutes (after 8:15A.M)*
- **Turnover time:** time between one patient leaving the OR and another patient entering the OR; the time needed to cleaning and preparing for the next patient
 - *Delayed turnover is considered when the time lag more than 25 minutes*
- **Finish Time:** the time the last patient of the schedule left the OR
 - *Early finish is considered to be those days where the operation ends 45 minutes prior to the normal available time (earlier than 3:15 P.M)*
 - *Late finish is considered to be those days where the operation ends 45 minutes after the normal available time (later than 4:45 P.M)*

- **Cancellation Rate:** the proportion of canceled cases from the total scheduled elective procedures

■ *High cancellation rate is considered when it is above 5% (>5%)*

- **Efficiency Rate:** of OT can be calculated with the following formula:

Efficiency =

$$\left[\frac{(\text{Fraction of scheduled time utilized}) - (\text{fraction of time over – running})}{(\text{fraction of scheduled completed})} \right] * 100\%$$

- Fraction of scheduled time utilized: is the actual time spent in the OT from the available scheduled time, fraction of time over – running: is the time spent in the OT beyond the normal working hours, fraction of scheduled completed: proportion of operated patients to scheduled patients.

■ *Acceptable efficiency is considered when the rate is >80%*

■ *Excellent performance is when the efficiency rate is >90%*

- OT utilization is calculated by taking the ratio of time wherein the patient stayed in the OR to the available time.

i.e. Utilization = $\frac{\text{Time Used}}{\text{Total Available time}}$

- Elective Surgery: is any surgical case that is booked into the operation theatre list prior to the day of surgery.
- In some of the OR days there were overlaps of procedures where some of the scheduled cases were operated on other free OT tables while the procedure listed before is still being operated on the scheduled OT table. In such circumstances, the table turnover time was not calculated due to the overlap. However, the time utilized in the free table was added to the total time used on the initial scheduled OT table.

Data Analysis Plan and Procedures

Data was analyzed using the Statistical Package of Social Sciences (SPSS) version 25.0 for Microsoft Windows. Means, Medians, Inter Quantile Ranges (IQR), standard deviations (SD) and percentages was calculated and relationship measures between variables will be assessed using Chi-square. The statistical significance at P-value < 0.05 will be accepted. The results are presented by the use of charts, tables, and texts.

Ethical Consideration

Ethical approval was acquired from SPHMMC institutional review board (IRB). Each information was collected using a structured checklist. Taking of consent wasn't needed to conduct the study and data was used for research purpose only.

Dissemination of Results

The output of this study will be submitted to the Department of Surgery and research directorate, St. Paul's Hospital Millennium Medical College in partial fulfillment of the requirement for a specialty certificate in General Surgery. Attempts will be made to publish the information in peer-reviewed journals and make presentations in scientific conferences.

Results

A total of 822 elective procedures were scheduled and 301 operation tables (Pediatric surgery=35, Urology=43, GynObs=67, CVTS=23, HPB=37 & general surgery=96) were available within the study period. A total of 747 (90.9%) cases were operated, averaging around 2.5 cases per table per day. Two surgeries were performed in a room per day in 42.5% of times, followed by three cases (29.5%), four cases (14.5%), one case (13%) and 5 cases in only one occasion. The highest average operated cases per day was seen in General surgery (3.08cases/OR table), the lowest being on CVTS subunit (1.7cases/OR table).

There were a total of 144,480 working minutes available for elective surgery during the study period shared among different units based on existing schedule, of which 128,766 minutes was actively used for performing procedures, averaging 427.7 ± 139 minutes per operating room in a given day (*Fig.1*). From the expected working hours of 480 minutes per room/day, highest utilization is recorded by CVTS subunit at 492.7 ± 170 minutes/room and the lowest being urology subunit with 340.4 ± 146 minutes/room (*Table 1*).

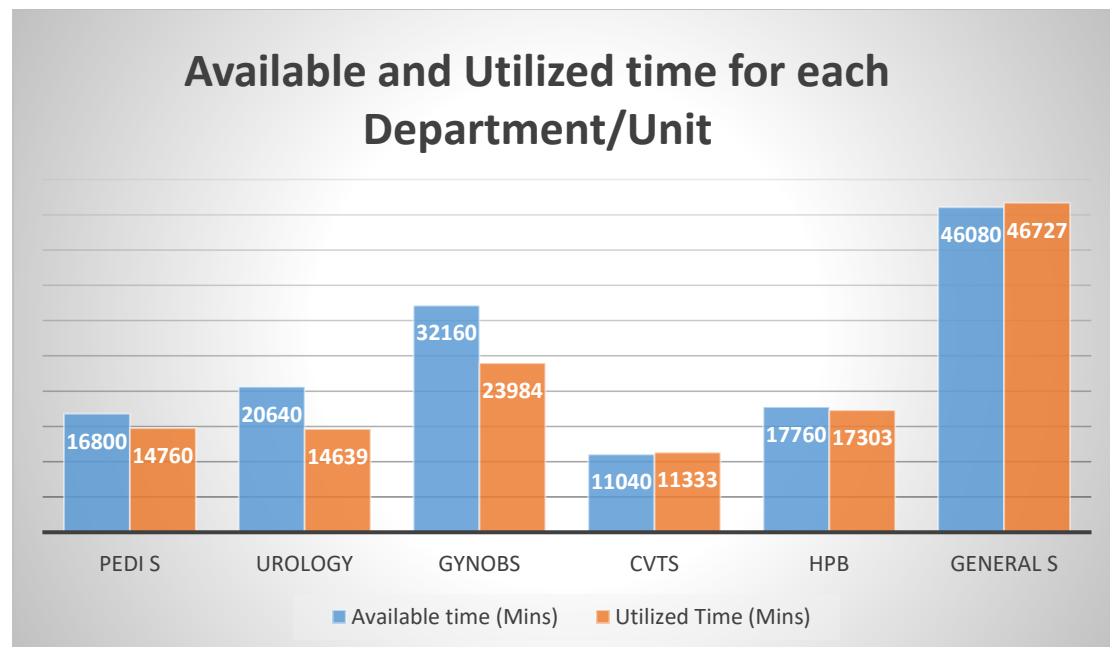


Fig. 1: Utilization of Available time in each department/Units, SPHMMC, 2022

A total of 747 procedures were performed out of the scheduled 822 cases. With 75 cancellations in all departments the cancellation rate was calculated to be 9.12%.

The rate of cancellation was highest in Pediatric surgery (11.21%) and lowest in GynObs (4.32%).

The commonest cause of cancellation was lack of operating time, where working hour ends before finishing of the scheduled cases, accounting for 46.7%, followed by medical reasons, accounting for 28%, which prevent to undergo the planned procedure on the day of schedule. No surgery was cancelled due to the absence of operating surgeon or other OR staffs.

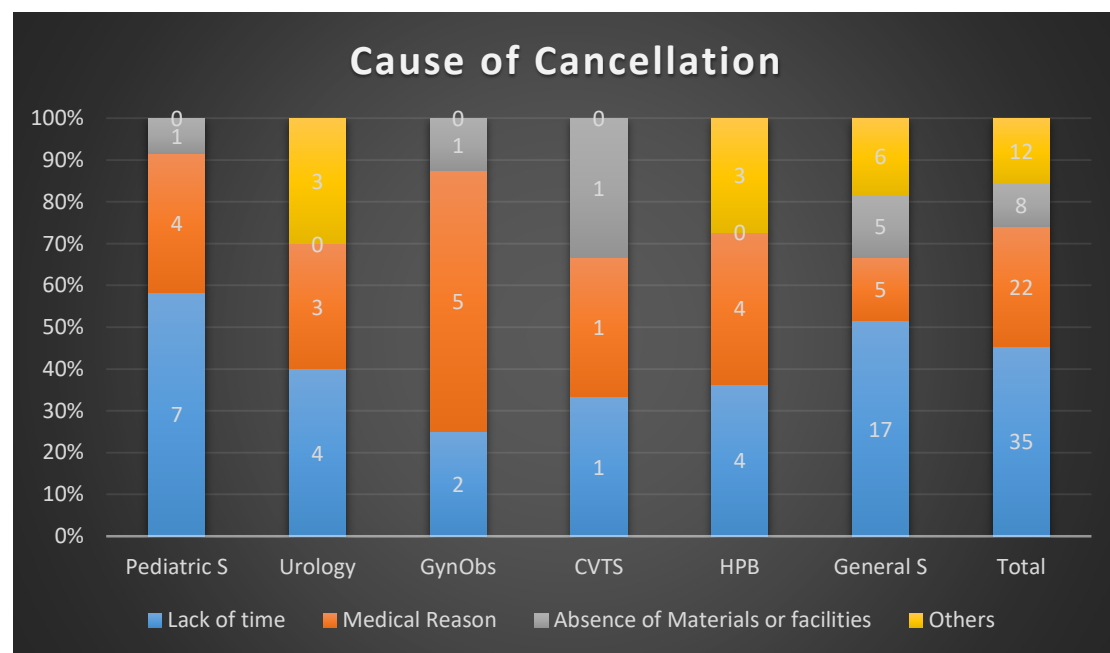


Fig. 2: Causes of cancellation in each department/Units, SPHMMC, 2022

There was a total of 8548 minutes overrunning times, where procedures were being performed beyond the available working hours. This accounts for around 6% of the total available time. General surgery used 3503 minutes while GynObs used only 285 minutes, accounting for 8% & 1% of available time, respectively. While the highest proportion of overrunning times was seen in CVTS subunit at 16% of available time, utilizing 1722 overrunning minutes (Table 1).

The average start time of the day was 8:02A.M $\pm$ 24 minutes, ranging from 7:15A.M to 10:30A.M. The earliest start time was seen in GynObs at 7:56A.M $\pm$ 14 minutes, whereas the unit with the late starts was registered at pediatric surgery at 8:16 $\pm$ 25

minutes. In 127(42.3%) of the available operating tables procedures commenced before the start of working hours, with average 12 ± 9 minutes.

Table 1: OR performances among different departments/Units, SPHMMC, 2022

	Pediatric Surgery	Urology	GynObs	CVTS	HPB	General Surgery	Total
Average Utilized Time (mins/table/day)	421.7	340.4	358.0	492.7	467.6	486.7	427.7
Scheduled Cases	107	100	139	42	105	329	822
Operated Cases	95	90	133	39	94	296	747
Average operated cases/table	2.71	2.09	1.99	1.70	2.54	3.08	2.48
Operated/scheduled cases	0.89	0.90	0.96	0.93	0.90	0.90	0.91
Over running time (mins)	963	810	285	1722	1265	3503	8548
Overrun time (ratio)	0.06	0.04	0.01	0.16	0.07	0.08	0.06

Late starts, first case of the day entering the OR after 8: 15A.M, were seen in 44 of 301 available OR tables (14.6%), with additional 42 delays seen after arrival of the patient until anesthesia induction or incision. The commonest reason being late patient arrival (37.2%), followed by late arrival of either the operating surgeon or the OR staff (31.4%) & absence of necessary materials or instruments on time (24.4%), the rest 7% of cases having other causes (*Fig. 3*).

The average Incision time being 8:38A.M $\pm$ 35 minutes, ranging from 8:20 $\pm$ 14 minutes at GynObs to 9:07 $\pm$ 27 minutes at CVTS subunit (*Table 2*).

The average time interval that took between patient exchange in 374 procedures was calculated 22 ± 26 minutes, ranging 1 to 113 minutes. Shortest and longest turnover time was recorded at urology (16 ± 9 minutes) and pediatric surgery (28 ± 18 minutes), respectively. Delayed turnover time was seen in 83 (21.9%) turnovers with 43 ± 26 minutes (*Table 2*).

The mean end time of procedures of the day was 2:59P.M $\pm$ 77 minutes, ranging from 8:50A.M to 9:00P.M. Earlier finishes was seen at Urology (1:49P.M $\pm$ 83 minutes), while late finishes was observed in CVTS (4:21P.M $\pm$ 95 minutes). Early finishes were observed in 156 OR tables (51.83%) while late finishes seen in 73 tables (24.25%). Highest proportion of early finishes observed in GynObs, in 49 of available

67 OR tables (73.1%); while 11 out of 23 available OR tables (47.8%) had late finishes in CVTS, accounting for highest proportion of late finishes (*Table 2*). The total utilization rate of was calculated to be 89.11%, which is within acceptable level. The utilization rate was ranging from 70.93% at urology to 101.4% at General surgery & 102.5% at CVTS subunit.

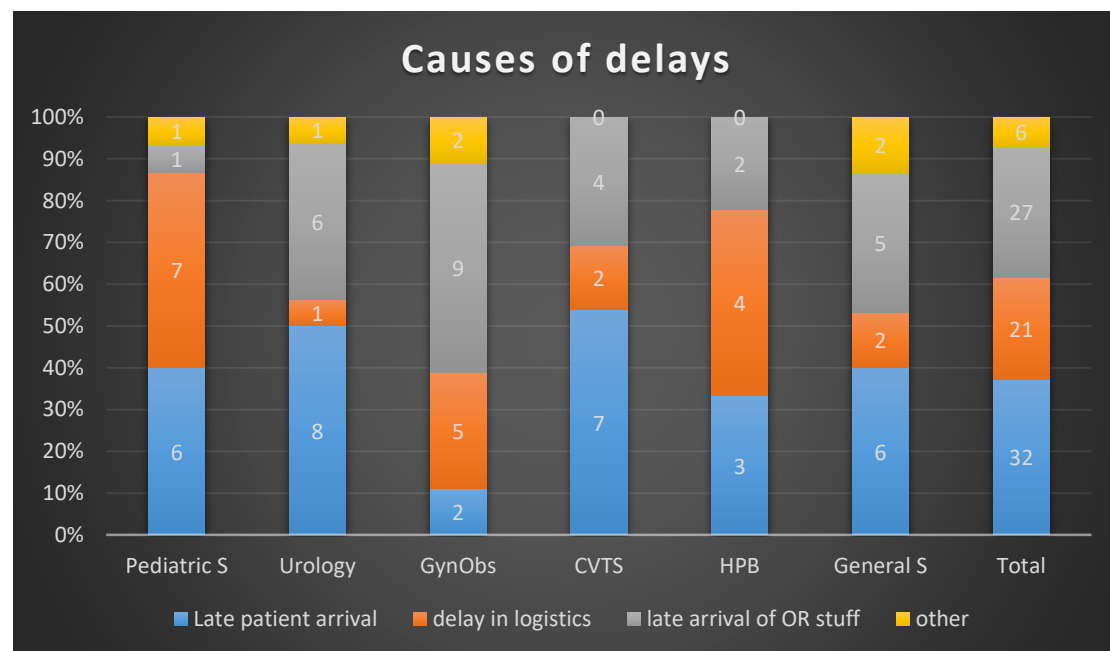


Fig. 3: Different causes of delays during conduct of the procedures among different departments/Units, SPHMMC, 2022

Whereas, the overall efficiency rate was lower than the utilization at 75.6%, with the lowest being 60.3% at Urology and the highest 84.4% in general surgery (*Table 2*). This rate is slightly lower than the acceptable 80% efficiency rate. However, when looked at individual performances General surgery, CVTS and HPB units had efficiencies at or above the acceptable standards.

Table 2: Starting, Turnover and finishing times; OR utilization & efficiency rates among different departments/Units, SPHMMC, 2022

	Pediatric Surgery	Urology	GynObs	CVTS	HPB	General surgery	Total
Available OR tables	35	43	67	23	37	96	301
Mean Start Time	8:16A.M ± 0:25	8:09A.M ± 0:13	7:56A.M ± 0:14	8:07A.M ± 0:18	7:59A.M ± 0:15	7:59A.M ± 0:32	8:02A.M ± 0:24
Mean Incision Time	8:47A.M ± 0:27	8:48A.M ± 0:13	8:20A.M ± 0:14	9:07A.M ± 0:27	8:34A.M ± 0:15	8:35A.M ± 0:51	8:38A.M ± 0:35
Mean Turnover Time	0:28	0:16	0:17	0:29	0:25	0:19	0:22
Mean Finish Time	3:18P.M ± 1:57	1:49P.M ± 2:23	1:54P.M ± 1:58	4:33P.M ± 2:35	3:46P.M ± 1:42	3:31P.M ± 2:08	2:59P.M ± 2:17
Late Starts	10	8	4	6	4	12	44
Early Finishes	17	32	49	6	14	38	156
Late finishes	9	9	2	11	11	31	73
Utilization Rate (%)	87.86	70.93	74.58	102.65	97.43	101.40	89.11
Efficiency Rate (%)	72.91	60.30	70.51	80.84	80.84	84.39	75.60

Correlation among certain variables (start time, turnover time and finish time and the number of procedures performed per table in a given day) with utilization and efficiency rates were done. The start time was shown to have statistically significant effect on neither the utilization nor the efficiency rates. The finishing time and the number of surgeries performed in a day have shown significant impact on both parameters, having *p*-values of <0.01. Delayed turn-over times had impact on the utilization rate but not on the overall efficiency (*Table 3*).

Table 3: Starting, Turnover and finishing times correlated with OR utilization & efficiency rates, SPHMMC, 2022

		Utilization (%)			Chi-Square	P-value	Efficiency (%)			Chi-square	P-value
		61-75	76-90	91-105			60-69	70-79	80-89		
Delayed Start time	No	98	28	134	4.68	0.096	36	90	134	0.35	0.84
	Yes	11	9	22			7	13	22		
Turnover time	≤ 25 mins	81	38	168	7.7	0.021	30	89	168	2.16	0.34
	>25 mins	17	21	44			6	32	44		
Finishing time	<3:15 P.M	80	18	56	36.68	<0.01	31	3	9	35.67	<0.01
	3:15-4:45	19	9	45			66	25	11		
	>4:45 P.M	11	9	54			56	45	74		
No. of surgeries performed in a day	1	28	1	12	46.6	<0.01	14	15	12	41.9	<0.01
	2	58	16	55			14	59	55		
	3	22	14	57			12	24	57		
	4	3	5	34			3	5	93		

Discussion

Efficient utilization of operating theatre is ideally achieved by early starts, short turnover times and timely finished with reduction of overrunning hours. Considering the resource limitations in low income countries, like ours, every effort has to be made to avoid wastage & poor utilization of OT times.

In our study in majority of the days two procedures were being performed, 42.5%. Similarly, two procedures were the commonest in a study done at Black Lion Hospital accounting for 39.6%, one case in 36.5%, which is significantly high as compared to our study, three cases in 16.4% and four case in 7.4% of cases ⁽¹⁷⁾.

Daily average used time in the study was 427.7 ± 139 minutes per operating room. This was higher as compared to average used time in South African study which was 266.4 ± 161.4 minutes ⁽¹⁶⁾.

The cancellation rate was calculated to be 9.12%, which is sub-standard, and high as compared to some studies; 4.4% in Lebanon ⁽⁵⁾. However, it's significantly low as compared to the reports from similar set ups: 35.8% & 27.3% in Addis Ababa, 23% in Jimma ^(17,18,4). This cancellation rate is, however, comparable to 8.9%, a report from the same setup done in 2018/19 ⁽²³⁾. The rate of cancellation was lowest in GynObs (4.32%), in contrary to the previous report of highest cancellation at the department at 18.3% ⁽²³⁾. Study from India showed lowest cancellation rate at GynObs <1% ⁽¹⁹⁾ having similarity with the lower cancellation rates seen in the study, but higher rates of cancellation observed in other studies 29.2% & 27.3% in Jimma & Addis Ababa ^(4,18). Highest rates of cancellation were reported at 23.7% from General Surgery in India, 41.5% from GynObs in Addis Ababa ^(19,18). Even though lowest rate of cancellation was reported at 18.2% from Pediatric surgery, this was a higher rate when compared to our highest cancellation from similar unit at 11.21% ⁽¹⁸⁾ and a comparable cancellation rate at pediatric surgery has been reported at 11.6% ⁽²³⁾. This lower cancellation rate might have a significant effect towards achieving relatively better efficiency rates in our study, though decreasing the rate of cancellation is still needed towards having improved efficiency rates.

Similar to our finding, other studies reported significant portion of cancellations ascribed to lack of operating time ranging from 33.4 - 62.2% ^(17,4,19), unlike the report from Lebanon ⁽⁵⁾. One of the appreciable findings from the study was none of the

surgeries has been cancelled due to absence of operating surgeon or OT staffs, which accounted for 8.7% of cancellations in Jimma ⁽⁴⁾.

Start time was shown to generally acceptable at 8:02A.M $\pm$ 24 minutes, even 42.3% of the available operating tables procedures commenced before the start of working hours, with average 12 $\pm$ 9 minutes, and only 14.6% started after 8:15A.M. Unlike to our finding, significantly late starts has been reported from a tertiary center in Addis Ababa 8:43 $\pm$ 25 minutes & 8:56 A.M $\pm$ 52 minutes ^(17,18).

A study from India reported late patient arrival (36.4%) & absence/malfunctioning of instruments and materials (27.3%) as a cause of delay ⁽¹⁶⁾. However, there were no significant difference in those early and delayed start times on the overall utilization & efficiency rates.

An acceptable turnover time was observed in the study at 22 $\pm$ 26 minutes. A comparable turnover time was reported at 25 $\pm$ 49 & 25.2 $\pm$ 31 minutes in Addis Ababa, 20 $\pm$ 17 minutes in South Africa ^(17,18, 21), however lower turnover was reported in India <10 minutes ⁽¹⁶⁾. There seems to be little benefit to try to improve this turnover time to effect better OT efficiency.

The average end time was 2:59P.M $\pm$ 77 minutes, with significant variation among different units. In around 52% of available ORs days the procedures ended prior to the working time, resulting in significant underutilization. This is slightly higher than the one seen in south Africa (46%), India (29%) & U.K; 1.3 & 38.9% ^(21,15,8). Improving proper utilization of available times should be given emphasis to have better efficiency rates.

There was a total of 8548 minutes overrunning times, consisting of 6% of total time used for performing the procedures. This is significantly higher number as compared to the overrunning time from South Africa which was 0.9%⁽²¹⁾. Majority of overrunning times are caused by late finished which occurred in 24.3% of available OR sessions. Late finishes were seen in U.K at 4.5% & 31.6% ⁽⁸⁾. Trying to minimizing overrunning times is important to improve efficiency and for possible OT staff satisfaction, since it avoids over burdens.

The total utilization rate is 89.1%, which is superior to some of the reports: 81% in Australia, 73.2% in U.K, 72% in Addis Ababa and 52.2% & 48% in South Africa ^(14,11,17,18,21,16).

An efficiency rate of 72-90% was reported from U.K, the average being higher from our finding 75.6% ⁽⁷⁾, and relatively comparable finding was reported at a rate of 80% from another study from U.K ⁽⁸⁾.

Even though it seems like logical to think that delay in starting times would affect the overall utilization and efficiency of the operating theatre it wasn't found to be statistically significant factor in our study. This might be due to differences in other parameters among different ORs. There was poor correlation with start and finish time on efficiency rates from a study in U.K, which was further augmented by experts on article review ^(8,22), which contradict to our finding since finishing time has been shown to result in statistically significant effect on both utilization and efficiency rates.

Conclusion

According to the study there was acceptable start times and turnover times and a variable finishing time. Even though higher cancellation rate was observed, significant reduction is seen from previous studies at teaching health institutes in the country. Similarly, higher proportion of overrunning time has been utilized, which might have significant consequences. Overall better utilization has been observed, though variation among units was evident. Overall efficiency was lower than expected but some unit achieved acceptable figures. Generally early finishes, higher rates of overrunning times and the number of surgery done in a given day has been shown to have statistically significant impact on the overall utilization and efficiency rates of operating theatres.

Recommendation

Improvements in proper utilization of available OR times to avoid early finishes and minimizing the overrunning hours is recommended to increase the efficiency rate of our OR performance. This will also help to minimize some of the cancellations. Further study is recommended to address the financial burden and patient & staff dissatisfaction following substandard efficiency rates.

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Data collection Form

Table No: _____					Specify Dep't/Unit: _____						
Day	Date	Case No	MRN	Start Time	Type of Anesthesia	Anesthesia Induction time	Incision Time	Closure Time	Sign out Time	If Delayed reason*	If canceled Reason**
		1									
		2									
		3									
		4									
		1									
		2									
		3									
		4									
		1									
		2									
		3									
		4									
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		2									
		3									
		4									
		1									
		2									
		3									
		4									
		1									
		2									
		3									
		4									

*** Causes of Delay**

1. Late patient arrival
2. Logistics
3. OR team late arrival
4. Other

**** Causes of cancellation**

1. Medical Reason
2. Lack of operating time
3. Absence of facilities/materials
4. Surgeon's absence 5. Other