ACHSM Asia-Pacific Journal of Health Management

RESEARCH ARTICLE

DETERMINATION OF THE STATE OF OPERATING ROOM EFFICIENCY IN A TERTIARY HOSPITAL IN THE PHILIPPINES

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ABSTRACT

OBJECTIVE:

This study aimed to describe the status of operating room (OR) efficiency of a tertiary hospital in the Philippines according to time-based parameters, identify the direct causes of delays in the OR, and predict the change in number of patients served and OR income if utilization rates improve.

DESIGN AND SETTING:

A cross-sectional study employing a retrospective records review of all elective surgical cases from June 2023 to June 2024 was done at a tertiary hospital in Pasig City, Philippines.

MAIN OUTCOME MEASURES:

The study determined the means of the different OR efficiency parameters, the causes of delays, the relationship between the changes in utilization rate and number of patients served, and the relationship between the changes in the number of patients served and the gross income.

RESULTS:

The means of the arrival of first case lag time, anesthesia induction lag time and turnover time did not reach target, while the means of the procedure lag time, trans-out lag time and utilization rate were optimal. Among the different causes of delay, those related to the surgeon predominated. The relationship between the change in utilization rate and change in the number of patients served was not significant. Likewise, there was no significant relationship between the change in the number of patients served and the change in gross income.

CONCLUSION:

While the means of the arrival of first case lag time, anesthesia induction lag time and turnover time were beyond target mainly due to surgeon-related factors, the utilization rate of the functioning operating rooms was optimal. Hence, the current number of functioning operating rooms may no longer be enough to address the existing backlog of cases. Increasing the number of functioning operating rooms may be considered.

KEYWORDS

Operating room efficiency, delays, elective surgery

INTRODUCTION

BACKGROUND

Operating room (OR) efficiency may be defined as the maximization of throughput and OR utilization, and minimization of overtime and waiting time, without additional resources.[1] Other studies define it in terms of cost reduction while preserving the same level of quality and productivity.[2]

The OR generates 60-70% of the entire hospital income but accounts for up to 40% of total operating costs.[3] Hence, OR efficiency warrants close examination, as it significantly affects hospital revenue and operational viability.

A study on OR efficiency in a low resource setting revealed that 42.7% of operating rooms were underutilized.[4] In a developing country like the Philippines, a certain government-funded tertiary hospital utilizes less than 50% of operating rooms despite the backlog of cases. Consequently, a patient seen at the outpatient clinic waits around a month before being scheduled for surgery. Attempts at monitoring delays and addressing their causes, especially the late arrival of surgeons, remain challenging for the management. While the maximization of OR utilization is crucial, the said hospital lacked data on OR efficiency.

Determining the level of OR efficiency and identifying modifiable factors enable implementation of strategies that prevent unnecessary delays. Especially for government hospitals in developing countries, wastage of the already limited resources may be avoided, and the number of surgeries per day may be increased. Moreover, improvement in the quality of patient care may be seen.

REVIEW OF RELATED LITERATURE

Several parameters that define OR efficiency in terms of time have been studied and their values set. [4, 5, 6, 7] The table below summarizes the definition and target of each parameter.

TABLE 1. OPERATING ROOM EFFICIENCY PARAMETERS [4,6,7]

OR Efficiency Parameter	Definition	Target
Arrival of first case lag time	Difference between the actual arrival time of the first case in the OR and the scheduled arrival time of the first case	≤ 15 minutes
Anesthesia induction lag time	Time difference between arrival time and start of induction of anesthesia	≤ 5 minutes
Procedure lag time	Time difference between start of induction of anesthesia and start of procedure	≤ 30 minutes
Trans-out lag time	Time difference between end of procedure and trans-out time	≤ 15 minutes
Turnover time	Time difference between trans-out time of previous case and arrival time of next case	≤ 30 minutes
Utilization rate	Proportion of time within the working hours in which a patient was in the operating room minus the excesses in lag times	≥ 75%

The lag times listed above have the advantage of being easily measured. Unfortunately, when taken in isolation, they do not consider how schedules with more cases tend to have lengthier gap times compared to those with less.[8] The utilization rate addresses this issue by relating the sum of the different gap times subtracted from the time the patient was in the OR to the total time required for a certain case.[7]

Other studies have utilized other OR efficiency metrics. Start time was easy to measure but definitions were varied and there was absence of correlation with finish time or efficiency. Cancellations on the day of surgery were routinely recorded and deemed important to patient experience by other studies. However, disruptions caused by cancellations were difficult to measure. The number of operations were easy to measure but it did not take into consideration the length of each operation.[8]

Causes of delays in the OR have been investigated by several studies. [5, 6, 9, 10, 11] Delays in the arrival of the first case and prolonged turnover time were due to transport delay, inadequate preoperative workup, consent issues, sudden cancellation, family discussion, clergy visitation, and power interruption. Scheduling error or change of plan, lack of timely OR preparation, and surgeon unavailability also delayed turnover. Anesthesia induction lag time was prolonged due to unclear staff assignments, late anesthesiologist, problems with setup, and difficult vascular access. Procedure lag time was prolonged due to late surgeon, incomplete supplies and instruments, equipment setup, radiology technician unavailability, and sterile field compromise. Trans-out time was delayed due to unavailability of stretcher and institutional worker, and lack of bed in the receiving unit. All the factors previously mentioned were attributed to patient, nurse, anesthesiologist, surgeon, or system. [9, 10, 11, 12, 13]

Current literature largely concentrates on institutions in developed countries, resulting in limited insight into how poor OR efficiency arise in low-resource settings. In fact, in the Philippines, very few published studies have measured operating room efficiency. Three studies done in the same local hospital in Luzon revealed that 49.7% of cases were delayed for more than an hour, mainly due to late surgeons,[5], the first case on time, entry lag, and exit lag were below the 50th percentile,[6] and no improvement in efficiency parameters was seen despite changes in policies.[14] The other published study, which was done in Visayas, attributed turnover time delays mostly to anesthesia and institutional factors.[15] While these studies measured specific OR efficiency parameters, quantification of the specific causes of delay is lacking. In addition, no study predicted the impact of improving OR efficiency on income and service delivery.

METHODOLOGY

OBJECTIVES OF THE STUDY

General Objective

To determine the state of OR efficiency of a tertiary hospital in the Philippines

Specific Objectives

a. To describe the efficiency of the OR according to time-based parameters
b. To identify the direct causes of delays in the OR
c. To predict the change in number of patients served and OR income if utilization rates improve

STUDY DESIGN

This was a cross-sectional study employing a retrospective records review of the Time Log Form of elective surgical cases.

STUDY SETTING

The study was conducted at the operating room complex of the Pasig City General Hospital (PCGH). PCGH provides surgical services such as general surgery, pediatric surgery, orthopedics, otorhinolaryngology, ophthalmology, and obstetrics and gynecology. The operating room complex has 5 operating rooms but only 1 to 2 are used for elective cases. About 2 to 4 cases are done per day, totaling around 50 cases a month.

POPULATION AND SAMPLING TECHNIQUE

The study population were all elective surgical cases scheduled at the operating room complex of PCGH. Cases that were done at the operating complex of PCGH from June 2023 to June 2024, scheduled as an elective procedure, and required anesthesia were included; while cases that required only local anesthesia, became an emergency case, and

had an American Society of Anesthesiologists - Physical Status (ASA-PS) classification of 5 or 6 (Appendix 1) were excluded. No sampling was done.

DATA COLLECTION PROCEDURE

Data extracted from the Time Log form (Appendix 2) was be recorded in the data collection form. To remove potential bias, the recorder was blinded as to who the surgeons, anesthesiologists, and patients were.

In order to project the change in the number of patients served and the OR income with improvement of utilization rate, the total number of elective surgeries, total number of emergency surgeries, and gross income were gathered. The total number of elective cases and emergency cases was obtained from the census of the Department of Anesthesiology. The gross income of the operating room was requested from the Finance Department of PCGH. These data were recorded in the data collection form.

This study was only conducted after its approval by the Research Technical Review Committee and Research Ethics Review Board of PCGH (Study Code 2024-004). Since this is a records review, the request to waive the requirement of obtaining consent from the subjects whose cases were logged in the Time Log Form was approved. All patient information was kept anonymous and confidential. Investigators assigned a numeric code for each case number to conceal the information. Only the investigators and the statistician had access to the data collection forms. The investigators complied with ethical principles, policies and relevant guidelines. Since this is an observational study involving a review of records, no more than minimal risk was involved.

DATA PROCESSING AND ANALYSIS

In order to describe the status of the operating room efficiency according to time-based parameters, means and ranges of OR efficiency parameters and the percentages of OR efficiency parameters that achieved the recommended targets were determined. To determine the direct causes of delays in the operating room, percentages of delayed cases according to cause per OR efficiency parameter were obtained. In order to predict the change in number of patients served and OR income if utilization rates improve, forecasting using simple linear regression (equation of the line approach) was done using the utilization rates, total number of cases and OR income as variables.

No missing data was encountered. The level of significance for all sets of analysis was set at a p-value < 0.05. The statistical software SPSS IBM Version 26 was used.

RESULTS

A total of 627 cases were included in the study. 283 were first cases while 344 were succeeding cases. Table 2 shows the means of OR efficiency parameters.

TABLE 2. MEANS OF OR EFFICIENCY PARAMETERS

OR Efficiency Parameter	Mean	Confidence Interval
Arrival of first case lag time	52.53 ± 86.30 minutes	43.48-63.59
Anesthesia induction lag time	17.53 ± 18.47 minutes	16.08-18.76
Procedure lag time	19.41 ± 13.02 minutes	18.39-20.43
Trans-out lag time	9.67 ± 8.40 minutes	9.01-10.33
Turnover time	56.39 ± 64.46 minutes	49.58-63.20
Utilization rate	78.75 ± 20.03%	77.18-80.32

The study revealed that 36.4% of OR efficiency parameters were delayed. Surgeons, particularly their unavailability, caused the most number of delays in the arrival of first case lag time (86.90%), turn-over time (81.82%), and in the anesthesia induction lag time (80.97%). The preparation of equipment for surgery caused the most number of delays in

the procedure lag time (44.79%), while the lack of personnel for transfer caused the most number of the delays in the trans-out lag time (51.92%). Table 3 summarizes the percentage contribution of each cause of delay.

TABLE 3. DIRECT CAUSES OF DELAYS IN PERCENTAGES

	Delayed arrival of first lag time (%)	Delayed turn-over time (%)	Delayed anesthesia induction (%)	Delayed procedure (%)	Delayed trans-out time (%)	Overall (%)
Patient	0.69	2.27	2.93	11.98	40.38	5.53
Puncture	0.00	0.00	1.80	11.98	0.00	2.14
Late emergence	0.00	0.00	0.00	0.00	38.46	2.19
Abnormal vital signs	0.00	0.00	0.68	0.00	0.00	0.33
No guardians	0.69	0.57	0.23	0.00	0.00	0.33
Extra preparation for obese	0.00	1.70	0.23	0.00	0.00	0.44
Adverse Events	0.00	0.00	0.00	0.00	1.92	0.11
Nurses	7.24	9.09	3.04	0.00	3.85	4.60
Availability of Nurses	1.72	6.82	2.82	0.00	3.85	3.18
Preoperative preparation	5.52	2.27	0.23	0.00	0.00	1.42
Anesthesiologist	0.34	1.70	8.67	2.08	0.00	4.82
Teaching case	0.00	0.00	0.23	1.04	0.00	0.22
Preparation of anesthetic needs	0.00	0.00	7.21	1.04	0.00	3.61
Availability of Anesthesiologist	0.34	1.70	1.24	0.00	0.00	0.99
Surgeon	87.59	83.52	81.42	26.04	1.92	72.45
Availability of Surgeons	86.90	81.82	80.97	25.00	0.00	71.58
Securing preoperative clearance /testing	0.69	1.14	0.45	0.00	0.00	0.55
Addressing concerns of patients	0.00	0.57	0.00	0.00	0.00	0.11
Skin prepping	0.00	0.00	0.00	1.04	0.00	0.11
Postoperative testing	0.00	0.00	0.00	0.00	1.92	0.11
Others	4.14	3.41	3.94	59.90	53.85	12.60
Procuring unavailable needs	0.69	0.00	0.23	1.04	0.00	0.33
Preparation of equipment for surgery	0.00	1.70	2.48	44.79	0.00	6.24
Positioning changes	0.00	0.00	0.23	5.73	0.00	0.71
Slow drug onset	0.00	0.00	0.00	8.33	0.00	0.88
Change in schedule	1.38	0.00	0.45	0.00	0.00	0.44
Lack of personnel for transfer	1.38	1.14	0.00	0.00	51.92	3.40
Change in room	0.00	0.00	0.23	0.00	0.00	0.11
Documentation	0.00	0.00	0.00	0.00	1.92	0.11
Cleaning of room	0.00	0.00	0.23	0.00	0.00	0.11
Availability of orthopedic technician	0.00	0.00	0.11	0.00	0.00	0.05
Miscommunication with schedule	0.69	0.57	0.00	0.00	0.00	0.22

Table 4 shows the monthly utilization rate, number of cases and gross income. The gross income provided by the accounting department of the hospital came from both elective and emergency cases and cannot be delineated. Given that the operating expenses of the OR also cannot be delineated between the elective and emergency cases, determination of the net income from elective cases alone was not feasible. Given this limitation, the monthly difference

in the number of emergency cases was analyzed. Analysis revealed that there is no difference in the monthly number of emergency cases from June 2023 to June 2024 (chi square value of 0, p=1.000). It was then assumed that the number of elective cases mainly contributed to the total number of monthly cases. Analysis was carried out to see how the change in the utilization rate related to the total number of monthly cases and how the change in number of cases related to the gross income.

TABLE 4 MONTHLY UTILIZATION RATE, NUMBER OF CASES AND GROSS INCOME

Month	Utilization Rate	Number of Cases	Gross Income
June 2023	78.55	154	917,434.62
July 2023	79.92	124	1,092,209.19
August 2023	79.71	167	1,239,304.01
September 2023	82.36	171	1,100,748.87
October 2023	83.22	166	943,907.66
November 2023	71.89	136	818,110.58
January 2024	71.45	177	663,747.69
February 2024	80.89	167	904,736.80
March 2024	80.30	149	934,146.75
April 2024	78.10	195	910,666.76
May 2024	81.00	169	1,047,428.15
June 2024	80.00	222	1,107,106.07

The utilization rate was compared to the total number of cases per month. The regression analysis revealed that utilization rate had a very little positive relationship with number of cases (B=0.874, p<0.697). The utilization rate accounted for 1.6% of the variance in the number of cases (F(1,11) =.160, p=0.697). The linear regression equation generated (y = 0.8742x + 97.403) means that for a unit increase in the utilization rate, the number of cases was around 98.

The number of patients was compared to the gross income. The regression analysis revealed that number of cases had a minimal positive relationship with gross income (B=873700.470, p<0.757). The number of patients accounted for 1.0% of the variance in the gross income (F(1,11) =.101, p=0.757). The linear regression equation generated (y = 598.47x + 873700) means that for a unit increase in the number of cases, the gross income was Php 874,298.47.

DISCUSSION

The means of the arrival of first case lag time, anesthesia induction lag time and turnover time exceeded the target times for each parameter. Less than 50% of the cases achieved the targets. On the other hand, the means of the procedure lag time, trans-out lag time and utilization rate were within the target times for each parameter. More than 50% of the cases achieved the targets.

Comparing results of this study with available data from the OR Benchmarks Collaborative, the mean patient into incision (which is the sum of anesthesia induction lag time and procedure lag time) was below the 50% percentile, the trans-out lag time was at 50% percentile while the mean turnover time was below the 50% percentile.[13]

In terms of the percentage of cases that achieved target, results of this study were higher in the arrival of first case lag time, procedure lag time and trans-out lag time compared to those of other studies. On the other hand, anesthesia induction lag time and turnover time were lower. [5,11]

Aggregation of the data of delayed cases revealed that majority of the delayed cases were due to unavailability or absence of surgeons in the operating room (71.58%), and issues with preparation of surgical equipment (6.24%) and

anesthesia needs (3.61%). Several local and international studies echo the same results with 54.3 to 80.6% of delayed cases being caused by surgeon-related factors particularly their tardiness. [5, 10, 16] Similar to the results of this study, other local and international studies saw that factors related to the patient and system only had minor contributions to delay. [5, 10, 16]

Carrying out interventions that will improve the availability of the surgeons may minimize delays. A notification system to alert physicians of the events in the OR has been shown to improve efficiency.[17] Tracking of surgeons and anesthesiologists who are frequently late may be done. Their tardiness may be tackled at the individual level and sanctions may be considered. Since surgeons have other duties outside the operating room that could delay their arrival, additional manpower may be considered.

The current utilization rate was within the target range of 75-85% mentioned by several references.[4,18] Utilization rates exceeding 85-90% in simulations have been shown to increase patient delays and staff overtime.[19] It may also indicate that the number of operating rooms is not enough to meet the demand.[18] Using the line equations generated, targeting 85% may increase the number of patients to almost 6, which may potentially yield an increase in gross income of Php 3,269.70. For curiosity's sake, a 100% utilization rate may increase the number of patients to almost 19, which may potentially yield an increase in gross income of Php 11,116.98. Hence, any further increase in utilization rate only has minimal effects.

When the current utilization rate is already within target, increasing the utilization rate of the existing functioning operating rooms is not recommended based on existing evidence. [18,19] Increasing it to the maximum recommended value adds very little to the number of patients and income. Since the backlog of cases is significant, the existing number of operating rooms is no longer enough to meet the current demand. Increasing the number of functioning operating rooms may be the way to address this problem rather than increasing the utilization rate of the existing operating rooms.

Limitations of this study were as follows. Parameters, particularly maximization of utilization of all operating rooms, maximization of throughput and minimization of resources, were not included. Causes of delay were limited only to those known to or observed by the anesthesiologist. Results of forecasting were limited by the unavailability of financial data on elective cases only. Since this was a cross-sectional study employing a retrospective records review, causation cannot be established, and biases and confounders may exist.

CONCLUSION AND RECOMMENDATIONS

While the arrival of first case lag time, anesthesia induction lag time and turnover time did not reach target, the utilization rate of the existing functional operating rooms in PCGH was at the optimal level. Surgeon-related factors caused the most number of delays.

Addressing surgeon-related factors to improve OR efficiency may seem logical. However, this study revealed that increasing the utilization rate of the presently functioning operating rooms may have no significant effect on the number of patients served and OR income. Since there is a considerable backlog of cases despite the optimal utilization rate, the current number of functioning operating rooms may no longer be enough to provide surgical services in a timely manner. Increasing the number of operating rooms may be the solution to address the backlog, and a feasibility study may be carried out to assess its viability. This study showed that predicting the impact of improved OR utilization on service delivery and revenues may guide hospital managers in deciding between improving the efficiency of existing operating rooms or expanding the OR complex.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved by the Research Ethics Review Board of PCGH with Study Code 2024-004. Since this was a records review, the request to waive the requirement of obtaining consent to participate from the subjects was approved.

CONSENT FOR PUBLICATION OF PARTICIPANTS

Not applicable

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed in this study are available from the corresponding author on reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

Not applicable

AUTHORS' CONTRIBUTIONS

MTBA had substantial contributions to the protocol design, data collection, analysis and interpretation, and drafting the final manuscript. CATA was involved in the revision of the protocol and final manuscript. KDM helped in data collection and analysis. All authors read and approved the final manuscript

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APPENDICES

APPENDIX 1. ASA-PS CLASSIFICATION

ASA-PS Classification	Definition
I	A normal healthy patient
II	A patient with mild systemic disease
III	A patient with severe systemic disease
IV	A patient with severe systemic disease that is a constant threat to life
V	A moribund patient who is not expected to survive without the operation
VI	A declared brain-dead patient whose organs are being removed for donor purposes

APPENDIX 2. TIME LOG FORM OF THE PCGH DEPARTMENT OF ANESTHESIOLOGY

Date	
Operating Room	
Case Number	
ASA-PS Classification	
Service	
Surgical Procedure	
Primary Anesthesiologist	
Anesthetic Technique	

Parameter	Time	Note	Cause/s of delay	Details
Arrival time		Time when patient arrives at the OR For first case: If arrival time exceeds **6:45 AM**, indicate cause of delay For other cases: If arrival time exceeds **30 minutes** from trans-out time of previous case, indicate cause of delay	☐ Patient ☐ Nurse ☐ Anesthesiologist ☐ Surgeon ☐ Others	
Start of induction of anesthesia		If GA: time at preoxygenation If sedation: time when first drug is given If RA: time at start of prep If start of induction exceeds **5 minutes** from arrival time, indicate cause of delay	☐ Patient ☐ Nurse ☐ Anesthesiologist ☐ Surgeon ☐ Others	
Start of procedure		Time of first incision or use of any instrument If start of procedure exceeds **30 minutes** from start of induction, indicate cause of delay	☐ Patient ☐ Nurse ☐ Anesthesiologist ☐ Surgeon ☐ Others	
End of procedure		Time of completion of surgical dressing or instrumentation		
Trans-out time		Time when patient has left the operating room If trans-out time exceeds **15 minutes** from end of procedure, indicate cause of delay	☐ Patient ☐ Nurse ☐ Anesthesiologist ☐ Surgeon ☐ Others	