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ORIGINAL RESEARCH

Assessing the Precision of Surgery Duration Estimation: A Retrospective Study

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Background and Objectives: The operating room (OR) is considered the highest source of cost and earnings. Therefore, measuring OR efficiency, which means how time and resources are allocated precisely for their intended purposes in the operating room is crucial. Both overestimation and underestimation negatively impact OR efficiency Therefore, hospitals defined metrics to Measuring OR Effeciency. Many studies have discussed OR efficiency and how surgery scheduling accuracy plays a vital role in increasing OR efficiency. This study aims to evaluate OR efficiency using surgery duration accuracy.

Methods: This retrospective, quantitative study was conducted at King Abdulaziz Medical City. We extracted data on 97,397 surgeries from 2017 to 2021 from the OR database. The accuracy of surgery duration was identified by calculating the duration of each surgery in minutes by subtracting the time of leaving the OR from the time of entering the OR. Based on the scheduled duration, the calculated durations were categorized as either underestimation or overestimation. Descriptive and bivariate analyses (Chi-square test) were performed using the Statistical Package for the Social Sciences (SPSS) software.

Results: Sixty percent out of the 97,397 surgeries performed were overestimated compared to the time scheduled by the surgeons. Patient characteristics, surgical division, and anesthesia type showed statistically significant differences ($p < 0.05$) in their OR estimation.

Conclusion: Significant proportion of procedures have overestimated. This finding provides insight into the need for improvement.

Recommendations: It is recommended to enhance the surgical scheduling method using machine learning (ML) models to include patient characteristics, department, anesthesia type, and even the performing surgeon increases the accuracy of duration estimation. Then, evaluate the performance of an ML model in future studies.

Keywords: efficiency, operating room, overestimation, underestimation, Saudi Arabia

Background

Among the many constituents of a hospital, the operating room (OR) is considered the highest source of profit and expenditure[1] and the second costliest component of providing surgical services.[2] Childers and Maggard-Gibbons assessed the financial reports of 302 hospitals in California and concluded that the average cost of one minute in the OR was $36 to $37, of which $20 to $21 were considered direct expenses.[3] Therefore, improving OR efficiency reserves financial resources, enhances patient safety, expands OR capacity, and increases the satisfaction of both patients and healthcare providers.[4,5]

Underestimating the duration of surgery results in prolonged surgeries.[6,7] On the contrary, overestimating the duration means that surgeries take less time than scheduled.[6,7] Although both negatively impact efficiency, underestimation is more critical as it burdens financial resources and leads to staff frustration for working more hours.[6] Furthermore, surgeons tend to overestimate the surgery duration to avoid taking longer than scheduled at the OR.[7]

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There are different contributors to OR efficiency in healthcare organizations, healthcare providers, and patients.[8] Healthcare organizations focus on “scheduling efficiency”, “financial efficiency”, and “operational efficiency”, which are directly influenced by healthcare providers through “practitioner-centered efficiency”.[8] However, the most crucial contributor to OR efficiency is “patient-centered efficiency”, which includes meeting patients’ expectations and improving their clinical outcomes.[8] Healey et al asserted that minimizing waste in OR time, lowering expenses, enhancing the quality of services provided, and realizing the impact of these three factors are the basis for maximizing OR efficiency.[9]

Measuring OR Efficiency

The OR is complex and exposed to various factors affecting workflow consistency.[6] Rothstein and Raval sorted these factors starting with patient factors, such as last-minute cancellation, surgeon factors, such as the late start of surgery, and system factors, including lack of surgical equipment.[5] Furthermore, Jeang and Chiang explained that the effort performed in the preoperative phase alone involves proper and accurate scheduling, equipment preparation, patient anesthesia, and prepping the theater and recovery room.[10] Surprisingly, out of the 80 activities performed in providing a surgical service, Russ et al pointed out that only 18 were intraoperative, and 29 involved communications, whether between hospital departments or between the hospital and patient.[11] Therefore, when aiming to measure OR efficiency, the previously explained OR nature and the factors affecting it require defining accurate and reliable metrics that evaluate efficiency objectively.[11]

The Canadian Pediatric Surgical Wait Times (CPSWT) Project defined metrics to evaluate OR efficiency, which many hospitals have adopt.[12] Fixler and Wright listed the main metrics: “off-hours surgery, same-day cancellation rate, first case start-time accuracy, OR use, case duration accuracy, and average turnover time”.[12] For example, Cincinnati Children’s Hospital recorded 5.7 hours wasted daily from the OR schedule due to same-day cancellations.[13] In addition, six sigma was implemented in an academic center in the United States to improve the first case start time from 49% to 92%.[14] In Saudi Arabia, Hassanain et al improved OR use in nine out of 12 hospitals, with one reaching an increase of 22% using the lean methodology.[15] Similarly, in the United States, Cerfolio et al applied lean to significantly minimize the average turnover time from 37 to 14 minutes by eliminating 10% of unnecessary actions.[16]

Ubiali et al presented the operating room efficiency (ORE) metric to calculate the efficiency based on “Preparation Time (PT), Utilization Time (UT), Turnover Time (TT), Block Time, Overrun hours, and Cancelled Case Time (CCT)”.[17] This metric is assumed to apply even to a limited amount of data; however, it must be validated before use.[17] Conversely, Charlesworth and Pandit argued that TT is an inaccurate reflection of performance as the number of patients increases.[18] In addition, TT hardly accounts for 15% of the OR schedule time; therefore, considering it in calculating the efficiency complicates the equation with little added benefit.[18] The equation proposed by Charlesworth and Pandit was based on OR schedule estimation and presumed that optimal efficiency was achieved when all scheduled surgeries were completed in their designated duration.[18] Additionally, exceeding the assigned surgery duration “over-run”, ending the surgery before its expected duration “under-run”, and same-day surgery cancellations were considered indicators of inefficiency.[18]

Surgery Duration Accuracy

Laskin et al reported that 42% of the surgery duration was overestimated, whereas 32% was underestimated by surgeons.[19] Dexter and Epstein and Gómez-Ríos et al explained that underestimation means surgeries exceed their scheduled duration, which delays the start of the following surgeries or cancels them.[6,7] In contrast, overestimating means that the surgery took less time than scheduled, wasting valuable minutes from the OR schedule.[6,7] However, Gómez-Ríos et al stressed the necessity of reducing OR underestimation because its expense per hour is highly significant compared to overestimation.[6]

To improve scheduling accuracy, Bartek et al developed a machine learning (ML) model to predict surgery duration and increase the prediction accuracy to 39%.[20] ML considers variables such as patient age, gender, clinical features, and the performing surgeon, which might affect the duration of the surgery, resulting in a more accurate and reliable estimation.[21] Similarly, Tuwatananurak et al used ML models to achieve a 70% decrease in imprecise surgery scheduling within three months.[21] Another study proposed a model using two linear regression methods that were significantly better than the system used by hospitals.[22]

Summary and Implications

Many studies have discussed OR efficiency and how surgery scheduling accuracy plays a vital role in increasing OR efficiency and reducing OR cancellation rate. Researchers have dedicated their efforts to increasing OR efficiency by improving surgery scheduling accuracy using advanced methods such as machine learning (ML) models. However, to the best of the authors' knowledge, there have not been any papers discussing OR efficiency regarding scheduling accuracy in Saudi Arabia. This study aimed to evaluate OR efficiency. It evaluates the accuracy of surgery duration to determine whether surgeries exceeded their scheduled duration set by the surgeon "underestimation" or finished before the scheduled time set by the surgeon "over-estimation". Additionally, the study aimed to explore the factors effecting the accuracy of surgery duration, such as the surgical department, anesthesia type, and patient characteristics.

Research Methodology

Research Design

This was a retrospective, quantitative study based on secondary data extracted from the OR database in the Hospital Information System (HIS) for both performed and canceled surgeries.

Variables

The variables used to assess the accuracy of surgery duration were patient age and gender, patient type, surgical division, anesthesia type, surgery month, surgery duration, and scheduled surgery duration.

Operational Definitions

Below in Table 1, each key term used in the study is explained.

Study Setting

This study was conducted in the Quality and Patient Safety Department and the Operating Room (OR) department at King Abdulaziz Medical City in Riyadh.

Study Sample

All elective surgeries performed from the 1st of January 2017 to the 31st and December 2021, were included in the study. The total sample size was 97,397. Surgical departments were sorted into divisions to ensure a proper sample size for each department. In addition, departments with fewer than 50 surgeries in any year of the five-year study period were excluded. Patients with surgery without an OR entry time, OR exit time, or scheduled surgery duration were excluded.

Table 1 Definition of Key Terms

Term	Definition
Operating room (OR) efficiency	A measure of how well time and resources are allocated for their intended purposes in the operating room.
Surgery duration	The time from the patient entering the OR until leaving it.
Operation start	The beginning of the incision.
Operation end	Suture end.
Surgery duration accuracy	The difference between the scheduled duration and the actual duration of the surgery.
Overestimation	Surgeries end before their scheduled duration set by the surgeon
Underestimation	Surgeries exceeding their scheduled duration set by the surgeon
Day operation patient	Patients who enter the hospital, perform the surgery and discharge on the same day.
Same-day surgery patient	Patients who are admitted to the hospital on the same day of surgery as in-patients.

Data Collection Methods

Instruments

Elective surgeries performed from the 1st of January 2017 until the 31st of December 2021 were extracted from the HIS into an Excel sheet. Likewise, canceled surgeries from the 1st of January 2019 to the 31st of December 2021 were collected from the OR database in an Excel sheet to identify the variables, clean the data, and code it for analysis. The study period for surgery duration accuracy was chosen based on the availability of data in the HIS, which has higher accuracy and reliability than collecting it from manual records.

Procedure and Timeline

The first stage involved collecting and analyzing the accuracy of surgery duration using surgery data. After extracting the data from the HIS into an Excel spreadsheet, the inclusion and exclusion criteria were applied. The duration of each surgery was calculated in minutes by subtracting the time of leaving the OR from the time of entering the OR. Based on the scheduled duration, the calculated durations were categorized as either overestimation or underestimation. Finally, each independent variable was categorized and coded for analysis.

Ethical Consideration

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the King Abdullah International Medical Research Center (KAIMRC) (H-01-R-005) and Imam Abdulrahman Bin Faisal University Institutional Review Board (IRB-PGS-2022-01-119). As this is a retrospective study, it was practically difficult to obtain informed consent from the study participants to participant in the study. Therefore, the ethics committee of this study specifically waived the requirement for informed consent.

However, the researchers considered the importance of data anonymization prior to study commencement. Therefore, the OR management department removed any patients identifiable information, such as Patients' names, from the dataset before handling it to the study researchers.

Analysis

Statistical Package for the Social Sciences (SPSS) software version 28.0.1.0. was used to analyze the numerical data. The descriptive analysis presented an overview of the accuracy of surgery duration. Bivariate analysis was performed using chi-square to test the difference between the independent variables: patient type, gender, age, surgery year, surgical division, anesthesia type, and OR estimation. Significance was determined with p values <= 0.05.

Results

The total number of surgeries performed from the 1st of January 2017 to the 31st of December 2021 was 97,397. In 2017, 16,964 surgeries were performed, 19,890 in 2018, and the number of surgeries continued to increase, reaching 20,334 surgeries in 2019. However, in 2020, the number dropped to 16,441 surgeries due to the COVID-19 pandemic and rose again to 23,768 surgeries in 2021. Table 2 presents the descriptive statistics of the surgeries performed.

Fifty% of surgeries were performed on male patients, and most patients were aged > 60 years (23%) and 3–12 years (20%). Day operation patients were the most common type, accounting for 62%. Additionally, in 2021, a new type of patient was introduced as "same-day surgery", but it accounted for only 0.7% of the total patients.

Moreover, general surgery (30%), pediatric surgery (15%), and ENT (14.0%) had the highest number of surgeries performed. At the same time, the adult organ transplant, hepatobiliary surgery, and neurosurgery divisions had the lowest rate of surgeries performed during all years (<2%). In addition, general anesthesia was the most commonly used anesthesia type, reaching 82%; conversely, nerve block and spine/epidural (<1%) were the least used.

From 2017 to 2021, more than 60% of surgeries were performed before their scheduled duration (overestimation), and the median duration of overestimation was 29. Consequently, the rate of surgeries exceeding their duration was 37% (overestimation) and the median duration of underestimation was 30.

Table 2 Descriptive Results of the Performed Surgeries from 2017 to 2021

Year	n (%)
2017	16,964 (17.4%)
2018	19,890 (20.4%)
2019	20,334 (20.9%)
2020	16,441 (16.9%)
2021	23,768 (24.4%)
Total	97,397
Patient Characteristics	**n= 97,397**
Gender	**n (%)**
Male	48,956 (50.3%)
Female	47,760 (49.0%)
NA	681 (0.7%)
Age	**n (%)**
0 to 2	3327 (3.4%)
3 to 12	19,166 (19.7%)
13 to 19	5088 (5.2%)
20 to 39	24,751 (25.4%)
40 to 59	22,488 (23.1%)
> 60 years	22,582 (23.2%)
Patient Type	**n (%)**
Day Operation	60,625 (62.2%)
In-Patient	36,057 (37.0%)
Same Day Surgery	714 (0.7%)
Surgical Division	**n (%)**
Adult Organ Transplant and Hepatobiliary Surgery	1259 (1.3%)
General Surgery	28,800 (29.6%)
Cardiac Surgery	3516 (3.6%)
ENT	13676 (14.0%)
Obstetrics and Gynecology	9218 (9.5%)
Neurosurgery	1579 (1.6%)
Ophthalmology	10,389 (10.7%)
Oral and Maxillofacial Surgery	5013 (5.1%)
Orthopedics	9611 (9.9%)
Pediatric Surgery	14,336 (14.7%)

(*Continued*)

Table 2 (Continued).

Anesthesia type	**n (%)**
General	79,817 (82.0%)
MAC	9693 (10.0%)
Topical	2293 (2.4%)
Spine/Epidural	398 (0.4%)
Spine	4550 (4.7%)
Nerve Block	493 (0.5%)
Other	153 (0.2%)
Surgery Duration	**n (%)**
The number of underestimated surgeries	35,931 (36.9%)
Underestimation (Median in minutes)	30.0
Underestimation (Min-Max in minutes)	0–1094
The number of overestimated surgeries	61,466 (63.1%)
Overestimation (Median in minutes)	29.0
Overestimation (Min-Max in minutes)	1–1271

Abbreviations: n, Sample size; %, Percentage; NA, Not applicable; ENT, Ear, nose, and throat; MAC, Monitored Anaesthesia Care; Min, Minimum; Max=, Maximum.

Table 3 Bivariate Analysis Results of the Independent Variables and the or Utilization

Gender	**Pearson Chi-square(χ^2)**	99.318	**p-value**	<0.00
			Overestimation	**Underestimation**
	Male		30,163 (61.6%)	18,793 (38.4%)
	Female		30,884 (64.7%)	16,876 (35.3%)
Patient Age	**Pearson Chi-square(χ^2)**	718.246	**p-value**	0.00
			Overestimation	**Underestimation**
	0 to 2		2177 (65.4%)	1150 (34.6%)
	3 to 12		13,544 (70.7%)	5622 (29.3%)
	13 to 19		3218 (63.2%)	1870 (36.8%)
	20 to 39		15,210 (61.4%)	9542 (38.6%)
	40 to 59		13,709 (70%)	8779 (40%)
	> 60 years		13,590 (60.2%)	8992 (39.8%)
Patient Type	**Pearson Chi-square(χ^2)**	2121.792	**p-value**	0.00
			Overestimation	**Underestimation**
	Day Operation		41,595 (68.6%)	19,030 (31.4%)
	In-Patient		19,410 (53.8%)	16,647 (46.2%)
	Same Day Surgery		461 (64.6%)	253 (35.4%)

(*Continued*)

Table 3 (Continued).

Surgical Division	**Pearson Chi-square(χ^2)**	5289.610	**p-value**	0.00
			Overestimation	**Underestimation**
	Adult Organ Transplant and Hepatobiliary Surgery		334 (26.5%)	925 (73.5%)
	General Surgery		17,284 (60.0%)	11,516 (40.0%)
	Cardiac Surgery		1147 (32.6%)	2369 (67.4%)
	ENT		10231 (74.8%)	3445 (25.2%)
	Obstetrics and Gynecology		6357 (69.0%)	2861 (31.0%)
	Neurosurgery		794 (50.3%)	785 (49.7%)
	Ophthalmology		7335 (70.6%)	3054 (29.4%)
	Oral and Maxillofacial Surgery		3619 (72.2%)	1394 (27.8%)
	Orthopedics		4365 (45.4%)	5246 (54.6%)
	Pediatric Surgery		10,000 (69.8%)	4336 (30.2%)
Anesthesia Type	**Pearson Chi-square(χ^2)**	2359.826	**p-value**	0.00
			Overestimation	**Underestimation**
	General		47,881 (60.0%)	31,936 (40.0%)
	MAC		7143 (73.7%)	2550 (26.3%)
	Topical		2150 (93.8%)	143 (6.2%)
	Spinal/Epidural		179 (45.0%)	219 (55.0%)
	Spine		3622 (79.6%)	928 (20.4%)
	Nerve Block		375 (76.1%)	118 (23.9%)
	Other		116 (75.8%)	37 (24.2%)

Abbreviations: χ^2, Pearson chi-square; %, Percentage; ENT, Ear, nose, and throat; MAC, Monitored Anaesthesia Care.

Statistical Differences Between Independent Variables and Surgery Duration Accuracy

The following paragraphs present the results of testing the significance of the difference between the study's independent variables and their surgery duration accuracy. Table 3 summarizes the findings of the bivariate analysis.

There was a statistically significant difference between the surgeries performed on males and females in terms of OR accuracy duration (p <0.00). Surgeries performed on females presented better estimation, with only 35% of surgeries being underestimated throughout the five-year study period (Table 3).

There was a statistically significant difference between age groups and their OR accuracy duration (p =0.00). For example, patients aged 3–12 years had the highest rate of overestimated surgeries, reaching around 71%. However, for patients aged between 40 and 59 years, the underestimation was 40% (Table 2).

Similarly, there was a statistically significant difference between patient types and their OR accuracy duration (p =0.00). Day-operation patients had the highest rate of overestimation (around 69%). In contrast, although around 54% of surgeries performed on inpatients were overestimated, it was the lowest compared with the others (Table 3).

There was a statistically significant difference in OR accuracy duration between the surgical divisions (p =0.00). Specifically, around 74% of surgeries in the adult organ transplant and hepatobiliary surgery divisions were underestimated, 67% in cardiac surgery, and 55% in orthopedics. In contrast, ENT (75%), oral and maxillofacial (72%), and ophthalmology (71%) presented the highest rates of overestimation.

Table 4 Bivariate Analysis Results of the Patient Gender and the Surgical Divisions and Patient Types

Department	Pearson Chi-square(χ^2)	11,176.786	p-value	0.00
			Male	**Female**
	Adult Organ Transplant and Hepatobiliary Surgery		851 (67.9%)	402 (32.1%)
	General Surgery		15,679 (54.9%)	12,906 (45.1%)
	Cardiac Surgery		2103 (60.3%)	1383 (39.7%)
	ENT		7561 (55.5%)	6051 (44.5%)
	Obstetrics and Gynecology		0	9218 (100.0%)
	Neurosurgery		846 (54.0%)	721 (46.0%)
	Ophthalmology		4922 (48.1%)	5310 (51.9%)
	Oral and Maxillofacial Surgery		2465 (49.5%)	2512 (50.5%)
	Orthopedics		5610 (58.8%)	3925 (41.2%)
	Pediatric Surgery		8919 (62.6%)	5332 (37.4%)
Patient Type	**Pearson Chi-square(χ^2)**	11,176.786	**p-value**	<0.00
			Male	**Female**
	Day Operation		32,526 (54.0%)	27,664 (46.0%)
	In-Patient		16,080 (44.9%)	19,738 (55.1%)
	Same-Day Surgery		349 (49.4%)	358 (50.6%)

Abbreviations: χ^2, Pearson chi-square; %, Percentage; ENT, Ear, nose, and throat; MAC, Monitored Anaesthesia Care.

Finally, there was a statistically significant difference between anesthesia types in terms of OR accuracy duration (p =0.00). First, topical anesthesia had the highest overestimation rate (> 90%), followed by spine anesthesia (80%). Conversely, spinal/epidural anesthesia had the highest underestimation rate, with 55% (Table 3).

Testing the Statistical Difference Among the Age and Hospital Departments

Below are the results of further testing the differences in the independent variables to clearly understand and justify the results. There was a statistically significant difference between gender and surgical divisions (p-value=0.00). Male patients went through adult organ transplant and hepatobiliary surgery (68%), cardiac (60%), and pediatric surgery (63%) more than females, Table 4.

There was a statistically significant difference between gender and patient type (p-value=<0.00). More than 50% of day operation surgeries were performed on males, whereas 55% of in-patient surgeries were performed on females, Table 4.

Discussion

As OR services are one of the highest costing services provided in a hospital and require effort from multidisciplinary teams, evaluating OR efficiency and continuously improving it significantly impacts hospital workflow and resources. This study aimed to evaluate the OR efficiency by measuring the accuracy of surgery duration.

To assess the accuracy of the case duration, 97,397 surgeries were analyzed from 2017 to 2021. Overestimation exceeded 60%, with a median of 28 min, whereas underestimation was 37%, with a median of 30 min. Although over half of the surgeries were overestimated, this is still a waste of valuable OR time. Therefore, understanding the factors affecting the surgery duration and improving the scheduling procedure to consider these factors enhances OR efficiency and reduces cost. In our study, patient characteristics, surgical divisions, and anesthesia types varied significantly in terms of the OR estimation.

Procedures done on female patients had lower overestimation than those on males by 3%. This was supported by a few studies stating that male surgeries took longer than scheduled.[23,24] In addition, many successful experiences in improving scheduling method accuracy have led to the development of machine learning (ML) models using patient characteristics.[20,21,25–29] A study stated that gender had a significant impact on surgery duration, where male surgeries had 7.5 minutes more than female surgeries.[25] On the other hand, few papers have discussed the factors leading to unforeseen intraoperative complications that might prolong surgery duration. Therefore, the findings were indecisive and varied among surgical procedures on whether gender significantly contributed.[30–36] For example, women are more prone to hypothermia during knee or hip replacement surgery,[33] whereas no difference was found between gender in video-assisted thoracoscopic surgery.[35]

To further understand our findings, we tested the rate of gender among the surgical divisions, which differed significantly. More than half of the patients in the surgical divisions with the highest rate of underestimation were males. For example, adult organ transplant and hepatobiliary surgery accounted for 74% of the underestimated surgeries, and 68% of the patients were male. Similarly, 67% of cardiac surgeries exceeded their scheduled duration, and 60% of the patients were male. Interestingly, one study reported that females had a lower chance of undergoing cardiac valve replacement surgery.[37] Therefore, the 3% variation in estimation in our findings could be attributed to the performance of the surgical division rather than gender influencing the surgery duration.

In addition, surgeries performed on patients between 20 and 29 years and above 50 years had either 40% or more underestimation, which correlates with the published findings stating that older patients did encounter prolonged surgeries.[38–40] A study revealed that surgeries performed on patients older than 65 years had 6 minutes increase in nonoperative time.[39] In addition to gender, age is essential in improving the accuracy of predicting surgery duration.[20,21,25–29,41] Additionally, a few papers concluded that older patients had a higher tendency for intraoperative complications, which might justify the longer durations.[31,35,36,42] However, this cannot be generalized as the complications vary among the various types of surgeries that have not been sufficiently covered in the literature. For example, older patients had a higher chance of intraoperative hypotension,[36] but were not reported to be at risk of intraoperative blood loss.[34]

Additionally, surgeries performed on inpatients presented the least overestimation compared to day operation patients and same-day surgery patients. Similarly, it was found that surgeries performed on inpatients differed significantly by prolonged duration compared to other patients.[43–46] A study noted 30 minutes increase in inpatient surgeries compared to outpatients.[46] Other studies have pointed out that in-patients who are male, older, or have a high body mass index (BMI)/ American Society of Anesthesiologists (ASA) class could be classified as the main contributors to prolonged surgeries.[23,28,47,48] In contrast, we found that 55% of inpatient surgeries were performed in females. However, testing other features such as BMI and ASA might reveal other correlations, as they were found to significantly affect surgery duration.[25,30,39,43,49]

Furthermore, all surgeries performed with local anesthesia (spinal, topical, nerve block), except spinal/epidural, outperformed surgeries performed with general anesthesia (GA) by at least 16% (nerve block) and reached 34% (topical) in overestimation. Additionally, Monitored Anesthesia Care (MAC), in which sedatives and/or local anesthesia are administered,[50] has higher overestimation than GA. Similar findings were found in the literature discussing the impact of the type of anesthesia administered on surgical duration. For example, a study noted a significant decrease of 40% in nonsurgical time when using local anesthesia and 20% when applying MAC over GA.[51] Another study on hip fractures found that GA surgeries were 30 min longer than local anesthesia.[52] Additionally, another revealed that local anesthesia decreased perioperative care by 2.1 days over the GA.[53]

Likewise, other studies compared spinal anesthesia (SA) to GA, in which surgeries administering SA presented a significantly shorter duration of 54 minutes in one;[54] however, it did not in the other.[55] Pierce et al, added other findings, such as that blood loss and length of hospital stay were lower in SA.[54] Similarly, SA presented a significantly higher overestimation of almost 20% than GA in the current study. In contrast, a study found that GA required less time to start surgery than SA (15 min vs 20 min, respectively).[55] Finally, our findings showed that spinal/epidural or epidural anesthesia (EA) had the highest rate of underestimation. This contradicts the findings of Ulutas et al, who stated that although the time taken to perform the surgery did not differ between EA and GA, the total OR duration was shorter in EA.[56]

Finally, surgical divisions differed significantly in their performance. The adult organ transplant and hepatobiliary surgery and cardiac and orthopedic surgery divisions exceeded their scheduled durations, reaching 73% in adult organ transplant and hepatobiliary surgery. Undoubtedly, the complexity of the surgery and the patient's condition directly affect the duration of surgery.[21,39,41,43] In the current study setting, most surgeries performed by these divisions were complex because of the advanced patient's condition; thus, they required longer durations. One study explained two causes of variability in the duration of surgery. One is the "Uncertainty" regarding uncontrolled, unexpected factors, such as complications. The other cause of variability is the "Diversity of Situation", related to identifiable factors such as patient characteristics, performing surgeon, and hospital resources.[57] Therefore, it is necessary to improve the surgical scheduling method to consider the remarkable variations among patients, surgery types, and even the performing surgeon.

Study Strength and Limitations

The strength of this study was the inclusion of a remarkable amount of data representing each independent variable. Additionally, these data were extracted from the HIS, excluding the chance of error, and supporting its accuracy and reliability. However, this study retrospectively analyzed independent factors and their impact on OR estimation. Therefore, analyzing additional factors such as BMI, ASA, and patient clinical condition with multivariable testing would help to provide further understanding of how these known factors affect surgery duration. Other aspects of the OR workflow have not been studied. For example, calculating the time of each stage in the surgery defines the pain points at which the time is mostly wasted.

Practical and Research Implications

It is recommended to use artificial intelligence methods, such as machine learning (ML) models to include patient characteristics, department, anesthesia type, and the performing surgeon in order to increase the accuracy of surgery duration estimation. It is also recommended to evaluate the performance of an ML model in future studies. In addition, it is recommended to improve the preoperative assessment by reassessing patients and contacting them for confirmation before surgery ensures the patient's readiness.

Conclusion

This study evaluated the OR efficiency by measuring the surgery duration accuracy. The majority of the surgeries performed were overestimated; this means that valuable minutes of the OR schedule were booked and wasted. The findings of this study provide insight into the importance of enhancing the surgical scheduling methods.

Data Sharing Statement

The data underlying this article will be shared on reasonable request to the corresponding author.

Disclosure

The authors report no conflicts of interest in this work.

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