Original Research Article

Assessing the Anaesthetic Time on Operation Theatre Utilisation and Case Cancellation

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Abstract

The time to perform an anaesthesia-related procedure at induction and emergence is often overlooked as part of the operation theatre (OT) utilisation time. This prospective observational study aimed to assess the estimation done by the surgeons and anaesthetists on anaesthesia times and the overall OT utilisation in our centre. This prospective observational study included elective cases from 13 surgical disciplines. The trainees, specialists and consultants from surgical and anaesthesia teams estimated the anaesthesia times separately before the surgical procedures. The actual anaesthesia, surgical, total procedural and turnover durations taken to complete the cases were documented. Operation theatre utilisations of those various surgical disciplines involved in the study were also analysed. We analysed 128 elective cases. The average mean time spent for anaesthesia procedures was 28.4 ± 14.1 min, with the mean induction time was 16.0 ± 9.8 min and the mean emergence time was 12.5 ± 8.6 min. Both anaesthetists and surgeons overestimated the anaesthetic times, but anaesthetists estimated closer to the actual anaesthetic times (r = 0.64 vs r = 0.49, respectively). There was no significant difference in the estimated anaesthetic times between different experience levels. All the surgical disciplines had average OT utilisation exceeding 90%, indicating overutilisation. A total of 12 cases (7.1%) were cancelled. Most cases were cancelled due to exceeded allocated block OT times (7 cases) or unavailability of ICU beds (2 cases). We concluded that OTs exceeding the given OT time is the most frequent reason for cancelling elective surgical cases on the day of surgery.

Keywords: Anaesthetics; health care costs; operating rooms; operative time; surgeons

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Introduction

Operating theatre (OT), despite being a hospital's most significant cost centre, has also been estimated as the most excellent revenue source (1). Operating theatre utilisation is the sum of the time taken to perform each surgical procedure (including preparation of the patient in the OT, anaesthesia induction, and emergence) plus the total turnover time divided by the time available. Strum et al. defined underutilisation as happening when allocated OT block time is not used for surgery, and overutilisation occurs when cases begin before or after a given block time (2).

Maximising OT utilisation is essential as lack of theatre time leads to case cancellations (3,4). Case cancellations can increase healthcare costs and have a negative emotional impact on the patients (5). Maimaiti et al. revealed over one year, the total cost of surgery cancellation was USD 92,049; out of this,

USD 42,668 (46.4%) was related to bed expense; USD 32,363 (35.1%) for direct costs associated with resources and supplies; and USD 16,569 (18.5%) was related to physician visits (6). The minimal cost involved per case cancellation in Universiti Kebangsaan Malaysia Medical Centre (UKMMC) is RM 100, which includes ward and treatment charges. Universiti Kebangsaan Malaysia Medical Centre caters for various types of surgeries based on elective, emergency, and daycare settings, and the number of elective cases performed in 2017 was 9015 cases, of which 1750 cases were cancelled (7). Because of exceeding the block of OT time, case cancellations contributed to 17% of the total number of case cancellations, amounting to a minimal cost of RM 29,750.

Efficient OT management demands the accurate prediction of the times needed for all care components, including surgeon-controlled time and anaesthesia-controlled time, for each surgical procedure. Veen-Berkx et al. found that the actual surgical-controlled time was approximately three times greater than the actual anaesthesia-controlled time (8). Tyler et al. concluded that optimum utilisation varies from 85% to 90%, mainly determined by the variability of case duration (9). Pandit et al. discovered that surgeons were poor at accurately predicting the actual time of the list ($r2 = 0.61$; $p < 0.001$) upon booking cases within their scheduled duration. Hence, they saw that 50% of the lists were predictably overbooked, 50% over-ran their scheduled time, and 34% were cancelled (4). This made us think that surgeons may not factor in the anaesthesia and the turnover times when booking their lists.

However, a study by Travis et al. found that anaesthetists should have considered the time taken to complete their procedure when they assessed the accuracy of surgeons and anaesthetists in predicting their time to complete their operations or procedures (10). As a result, we conducted a study to compare the anaesthesia time estimated by the surgeons and anaesthetists with the actual anaesthesia time. We also investigated the overall OT utilisation and cancellations of cases among the surgical disciplines.

Materials and Methods

This prospective observational study was conducted in UKMMC, General Operating Theatre (GOT) after obtaining approval from the UKMMC Research & Ethics Committee (FF-2019-013). This study was conducted between December 2018 and February 2019. The investigator briefed the surgical and anaesthetic teams and general anaesthetic (GA) nurses on the flows and definitions of the study parameters on the morning of the surgery. The investigator randomly recruited cases from various surgical lists involving inpatient elective surgeries which required anaesthesia services. These recruited surgical lists and the surgical disciplines involved were documented.

Before the induction of anaesthesia, the attending GA nurse documented the estimated anaesthesia times from the respective members of the surgical and anaesthetic teams separately. Both teams were blinded by each other's estimations. The team member who performed the estimate can be a trainee registrar, specialist, or consultant. The attending anaesthetists documented the actual anaesthetic, surgical and turnover times.

In this study, anaesthesia time consisted of induction and emergence time. We defined induction time for GA as time taken from the time the anaesthetic was administered to the time when the patient completed positioning and/ or completion of other surgical preparations that occurred before the operative procedures. Induction time for regional anaesthesia and central neuraxial block was defined as the time from sterilising the injection area until dressing was applied to the injection site. Emergence time following general anaesthesia was defined as the time taken from anaesthetic delivery was stopped until patients made a non-reflex response to verbal commands in adults. Meanwhile, in paediatric patients it was until localising motor response was observed. For regional anaesthesia, emergence time was documented as the time taken from the last stitch applied till the application of dressing to the surgical wound. If a patient requires a Post-Anaesthetic Care Unit (PACU)/ General Intensive Care Unit (GICU), admission emergence time would be taken from applying the last dressing until the patient was ready to be pushed to GICU/ PACU. In our local setting, PACU consisted of 4 beds in the OT complex that offered intensive care services to post-operative patients. However, the stay was limited to only 24 hours post-operative, and after that, the patients will be transferred to another intensive care area or the ward if needed.

We considered the turnover time starting from the prior case was wheeled out from the OT until the following case entered the OT. Therefore, in our study, the total procedure time was the duration taken starting from the patients entered the OT until the patients left the OT. These definitions of various timings of study parameters were made available in each OT for reference.

Unexpected events that led to delays in anaesthetic times were documented. If patients' procedure was cancelled even when the patients were already in the OT due to unforeseen reason (e.g., uncontrolled hypertension, sudden OT electrical blackout, implant failure), they were dropped out from analyses of anaesthetic times. Still, they were included in the analyses of OT utilisation. To evaluate the OT utilisation, OT lists of the recruited cases were followed up the next day. The starting and completion time of the lists were documented. The calculation of OT utilisation was based on the block OT time allocation. Each surgical list was allocated block OT times. Most OTs are given seven hours; some are extended to 10 hours of the block OT time based on the surgical disciplines. Any cancellations of cases from the list were also noted, and reasons for cancellations were recorded.

Statistical Analysis

The sample size was estimated using two means: the formula for a matched sample to determine the differences between actual and estimated time. Based on Travis et al. study, which detected mean differences in anaesthetic procedure time predicted by anaesthetists and the actual time was 35.2 min ± 26.9 min (10) and considering the 5% level of significance and 80% power of the study, a statistical power analysis indicated that minimum sample size was 114. Including the possibility of a 20% drop-out, 138 samples were required.

Data obtained from this investigation was analysed using a statistical package for social sciences (SPSS) version 25. Frequency and percentage were reported for the distribution of categorical variables, while continuous variables were reported as mean ± standard deviation (SD). Based on the Kolmogorov-Smirnov test, the normality distribution assumption for all the variables was met; therefore, the parametric test was used. The One-way ANOVA was applied to determine the significant difference in outcome variable between the groups, and a paired t-test was used to assess the significant difference between estimated anaesthetic time and actual time among anaesthetists and surgeons. Pearson correlation test was used to determine the correlation between estimated and actual anaesthetic time. Any detected differences were considered significant if the p-value showed less than 0.05.

Results

The study involved 13 surgical disciplines (Fig. 1). 128 out of 138 elective surgical cases from 59 listed surgical OT days were analysed after excluding those with incomplete documentation and irrelevant respective timings.

There were statistically significant mean differences between anaesthetists' and surgeons' estimated and actual anaesthetic times (Table 1). Both teams overestimated the anaesthetic times, but anaesthetists (r = 0.64) had estimated closer in comparison to the

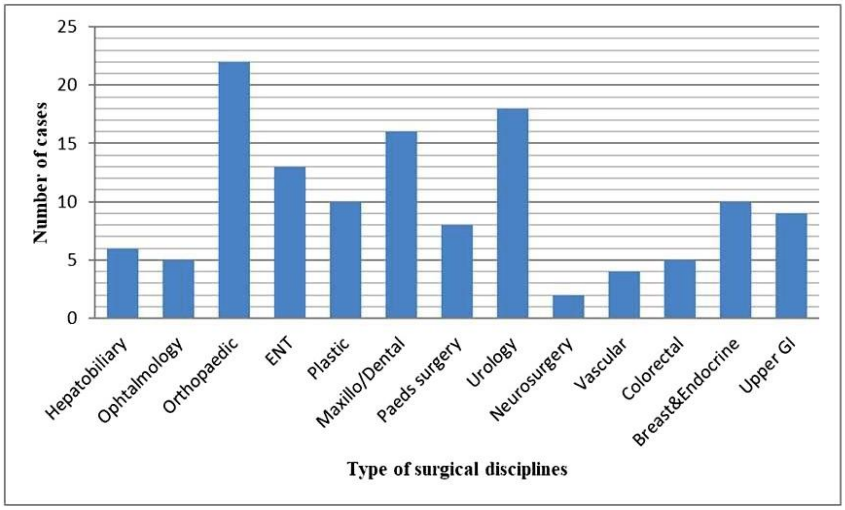

FIGURE 1: Distribution of cases based on different surgical disciplines involved

TABLE 1: Comparison between estimated and actual anaesthetic times among anaesthetists and surgeons in minutes and their experience level. Values are expressed in mean and standard deviations

Teams	*n*	Variable	Mean ± SD, (minutes)	*p*-value
	128	Actual time	28.4 ± 14.1	
	128	Estimated time	32.5 ± 14.6	< 0.001
		Estimation based on level of experience		
Anaesthetists	84	Trainee	31.9 ± 13.8	
	28	Specialist	30.8 ± 13.5	0.210
	16	Consultant	38.4 ± 19.8	
	128	Estimated time	36.4 ± 15.8	< 0.001
		Estimation based on level of experience		
Surgeons	51	Trainee	36.1 ± 14.0	
	47	Specialist	33.3 ± 14.0	0.064
	30	Consultant	41.9 ± 20.0	

surgeons (r = 0.49) to the actual anaesthetic time (Fig. 2). Table 1 also showed no significant mean differences between the estimations of anaesthetic times given by postgraduate trainees, specialists or consultants of both teams. Eight cases had delayed actual anaesthetic times due to various reasons. Reasons for the delayed anaesthetic time were to treat bradycardia, reintubate when a leak was detected from the endotracheal tube, resolve a surgical equipment failure and anaesthetic technical issue, locate the subarachnoid space, position an obese patient and obtain IV accesses.

Among the recruited cases, the average mean time spent for anaesthesia procedures was 28.4 ± 14.1 min, 20.9% of the total OT time, whereas the average mean time spent for the surgical procedures 112.2 ± 78.9 min, 62.6% of the total OT time (Table 2). The mean time spent during turnover was 23.1 ± 15.4 min, 16.5% of the total OT time. Most surgical disciplines had average OT utilisation exceeding 90%, indicating overutilisation. Neurosurgery, breast & endocrine, and urology teams were among the surgical disciplines with the highest average percentages of OT utilisation. Colorectal, Ophthalmology and Otorhinolaryngology (ORL) teams were surgical disciplines with average rates of OT utilisation closest to optimum.

There was 168 cases listed in those 59 surgical lists. A total of 12 cases (7.1%) were cancelled, of which nine were cancelled for reasons. All three cases cancelled without any documented reasons were from the urology lists. The reported reasons were an overextended allocated block OT time (7 cases) or the unavailability of ICU beds (2 cases). As for the incurred cost, as patients were admitted and did not proceed with their planned surgeries, a minimum expenditure of RM1200 was made following the cancellation of those 12 cases. The expected hospital revenue from these cancelled cases was RM 5880.

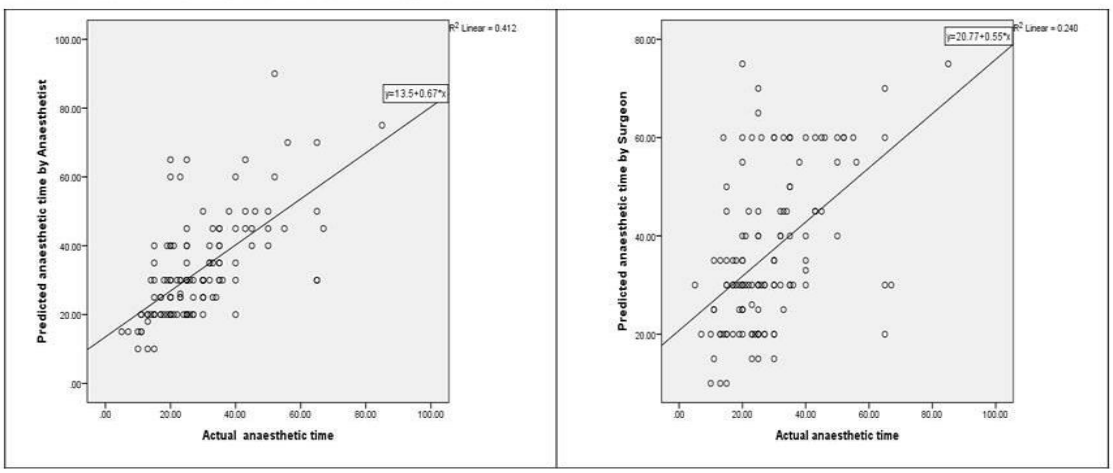

FIGURE 2: Correlation between estimated anaesthetic times by anaesthetists and surgeons with the actual anaesthetic times

TABLE 2: The average OT utilisation expressed in percentage based on different surgical disciplines

Surgical disciplines	Number of surgical OT lists, n=59	Average OT Utilisation, (%)
Neurosurgery	3	127.3
Breast and endocrine surery	4	125.5
Urology	7	123.3
Upper Gastrointestinal surgery	4	116.5
Vascular surgery	2	109.0
Plastic surgery	4	107.0
Hepatobiliary surgery	2	105.5
Orthopaedic surgery	8	99.5
Maxillofacial surgery	7	98.4
Otorhinolaryngology surgery	7	96.4
Ophthalmology surgery	4	95.3
Colorectal surgery	3	93.0
Paediatric surgery	4	61.3

Discussion

Contrary to our hypothesis, we revealed both anaesthetists and surgeons overestimated the anaesthetic times. For these groups of cases included in the study, the actual duration of induction and emergence of anaesthesia was faster than estimated, possibly because they were uneventful events. We thought we will find anaesthetists to underestimate their anaesthetic times, as observed by Travis et al. in their study. They included emergencies that could result in unexpected events at induction or emergence, delaying anaesthetic times (10). However, a study by Schuster et al. reported that emergency status did not significantly affect the processing time of any anaesthetic technique (12).

Our study demonstrated that different experience levels in anaesthesia or surgical training did not affect the estimated or actual anaesthetic times. For each case, there were different experience levels among the anaesthesiologists and surgeons, giving the estimated anaesthetic time. The vascular surgical team estimated the longest anaesthesia time. Most vascular procedures were conducted under regional anaesthesia. We postulated that they were unfamiliar with the regional anaesthesia techniques to be provided to their patients. Furthermore, our centre has a designated area for regional anaesthesia, while another case is in progress. Thus, they were unsure of how long to estimate the anaesthesia time.

We demonstrated that anaesthesia used a fifth of the total OT time. In comparison, a study by Vinukondaiah et al. found a shorter total anaesthetic time than the total available operating time (13). Compared to their research, our study's mean percentage was higher as the rate was based on each case, excluding turnover times. In contrast, Vinukondaiah et al. measured it out of total available operating time; including turnover times or possibly their duration of surgical time was longer. Hence, the denominator was different. Therefore, bookings and planning for a surgical procedure duration should include both anaesthetic times and turnover times to prevent underestimation of the total duration for the list of the day, hence preventing overbookings.

Optimum OT utilisation, as concluded by Tyler et al., is when the OT is utilised between 85% and 90%. They simulated that an operating room should have operational goals with cases to start within 15 minutes of the scheduled time and have the cases end no more than 15 minutes past the scheduled time at the end of the day (9). Paediatric surgeons were observed to underutilise their OT. However, it appeared so because their lists mainly consisted of multiple short procedures or if a complex case was planned, they would list a single case for that day's OT list. Furthermore, some elective surgeries of other disciplines included paediatric patients, which offloaded the paediatric surgical list.

From the present study, the OTs of Colorectal, Ophthalmology and ORL were among the surgical disciplines that we observed that had the least overutilisation of OT. This could be attributed to the ability of these surgical teams to estimate the anaesthesia, surgical, and turnover times well when considering how many cases to be listed. Those OTs that were overly utilised probably underestimated their surgical procedure times. As indicated by this study, they estimated the anaesthesia times almost similarly to other surgical teams, which had lists close to optimum OT utilisation. Therefore, they over-listed the number of cases they could operate within the allocated block OT times.

Case cancellations result in substantial financial losses to the hospital. According to a study in a university hospital in Finland, on the day of surgery, cancellation caused an economic loss of nearly a million euros over a nine-month study period (14). We would need a larger sample size to study the impact of cost following case cancellations. Despite being underpowered, we detected similar reasons for the case cancellations which were found in other studies due to inadequate OT time (15-17). The other reason for the case cancellation in our study was the unavailability of post-operative critical care support. This was parallel to a study by Gillies et al., where an increased risk of cancellation was closely linked to the requirement for postoperative critical care (18). We recently established a four-bedded PACU, which is separated from but near the post-anaesthesia recovery area. The PACU is fully equipped like an ICU, dedicated to offloading the burden of elective booking OT cases for critical care postoperatively. It will be interesting to see if PACU has reduced the cancellation rate due to the unavailability of critical care services postoperatively. We suggest that anticipated postoperative ICU requirements be booked through the standard electronic booking system currently in use, which will be more transparent for surgeons when listing major cases by various surgical teams, and they will be aware of the probability of availability of ICU beds postoperatively.

An independent dedicated timekeeper should monitor the actual anaesthetic time and other respective times to record them accordingly. As the anaesthetic time involves induction and emergence, which demands complete focus on patients, the anaesthetists who are in charged may tend to forget the exact timing involved. The presence of other distracting factors during the conduct of anaesthesia timing may make it more inaccurate. As mentioned earlier, a larger sample size is needed to empower the study to assess the effect of case cancellations on costs.

Schuster et al. detected that residents took longer induction time in general anaesthesia when it involved placement of a central venous catheter or laryngeal mask airway (12). As we only recorded the time to complete the anaesthetic phases and did not look specifically into each procedure performed either during induction or emergence of anaesthesia, we cannot illustrate whether anaesthetic procedures performed during these two phases affected the duration of those phases, which might directly affect the anaesthetic time duration. In future studies, details of the induction or emergence techniques and associated events should be included.

Conclusion

In conclusion, in our centre, anaesthetists and surgeons overestimated the actual anaesthetic times, and most OTs were over-utilised. Cancellations were mainly due to inadequate OT time or unavailability of GICU beds. We suggest that the electronic recording system should include time allocation for the anaesthesia and turnover times, not just the surgical times, to improve OT utilisation.

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