ORIGINAL ARTICLE

Comparison of the Incidences of Anesthesia-Related Adverse Events in Patients Undergoing Surgery in the Daytime, Care Transition, and After-Hours Period

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Background: The timing of surgery might affect anesthesia-related adverse events due to limited personnels, inadequate supervision, and/or lack of equipment, especially after-hours period.

Objective: To compare the incidence of adverse anesthesia events in patients undergoing surgery in different periods of the day.

Materials and Methods: A retrospective cohort study was performed in adult patients who undergone surgery under anesthesia at Siriraj Hospital in 2020. Patients were randomly selected and categorized into three groups according to the time of anesthesia, Group 1, daytime anesthesia group (8 a.m. to 4 p.m.), Group 2, anesthesia with care transition between the daytime and after-hours period, and Group 3, after-hours anesthesia group (4 p.m. to 8 a.m.). The patients' demographic data, surgical-related, anesthesia data, and anesthesia-related adverse events were reviewed from the hospital electronic medical records. Analysis was performed to compare the incidence and determine the risk factors associated with adverse anesthesia events.

Results: One thousand two hundred patients were included in the present study with 600, 400, and 200 patients in groups 1, 2, and 3, respectively. The overall incidence of adverse anesthesia events was 5.3% with 6.7%, 3.5%, and 5.0% in groups 1, 2, and 3, respectively (p=0.090). The most common adverse anesthesia event was difficult intubation at 1.5%. The factor found to be significantly associated with anesthesia-related adverse events was the non-operating room anesthesia (OR 5.97, 95% CI 2.94 to 12.13, p<0.001).

Conclusion: The present study was unable to demonstrate a significant difference in the incidences of anesthesia-related adverse events among the various anesthesia periods.

Keywords: Anesthesia; Perioperative; Adverse events; Time of anesthesia; After-hour anesthesia

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Safety is the top priority in anesthesia services. Patients' characteristics and co-morbidities play a significant role in many perioperative adverse events[1]. However, surgical and anesthesia factors, such as the type of surgery[2], the American Society of Anesthesiologists (ASA) classification[3], type of anesthesia, emergency surgery, and prolonged anesthesia[4], can affect adverse anesthesia events as well. Human errors, encompassing knowledge-based errors, skill-based errors, and systemic errors, can contribute to adverse anesthesia events. Errors like inexperience, inadequate care, and lack of supervision, more prevalent during nighttime services, may increase the likelihood of adverse anesthesia events[5-7]. Previous studies that examined surgical and anesthetic outcomes concerning the timing of surgery have been limited, with varying findings[6,8-10]. The objectives of the present study were to compare the incidence of anesthesia-related adverse events among patients undergoing surgery at different times of the day and to assess the risks associated with anesthesia-related adverse events in each group.

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Materials and Methods

The present study protocol was approved by the Siriraj Institutional Review Board of Mahidol University (COA No. Si 861/2020). This was a retrospective descriptive study of adult patients

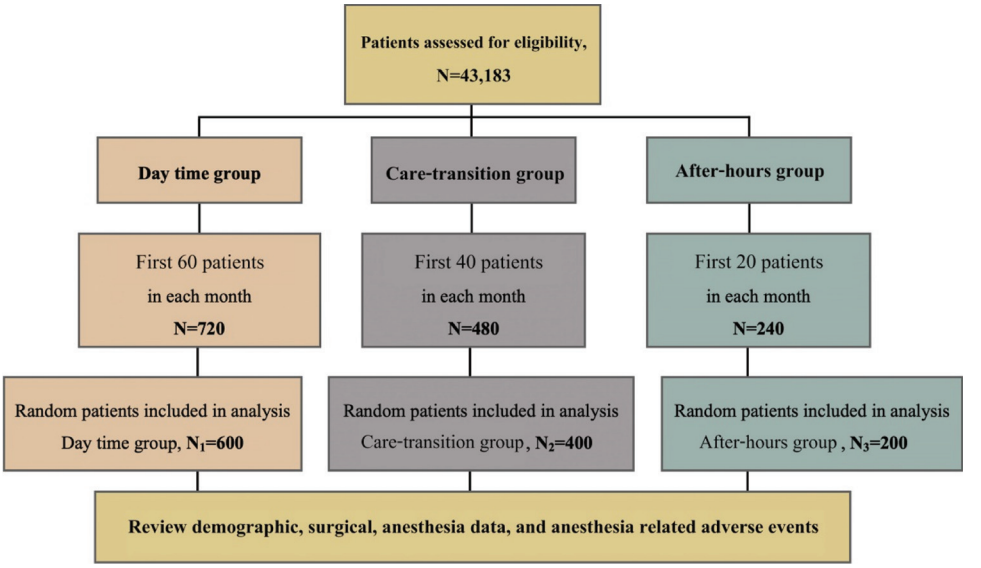

Figure 1. Sample size randomization and allocation.

undergone surgery or procedures under anesthesia at Siriraj Hospital, Mahidol University, Thailand between January and December 2020.

Participants

Adult patients aged at least 18 years old who had undergone surgery or procedures under anesthesia in 2020 at Siriraj Hospital were considered for inclusion in the present study. The exclusion criteria were cases that had undergone anesthesia from a specialist clinic that operated during after-hours periods in which anesthesia trainees were excluded from providing services, cases in which anesthesia had been provided at the weekend or on a public holiday, cases that had missing start and end anesthetic times, and cases that missed anesthesia records from Siriraj's anesthesia database or that had no data regarding adverse anesthesia events.

Randomization

The present study was carried out at Siriraj Hospital, Thailand, a tertiary, university hospital with anesthesia training. Anesthesia services for elective daytime cases start between 8 a.m. and 4 p.m., while the after-hours services are between 4 p.m. and 8 a.m. the next morning and typically have limited anesthesia staff and other healthcare personnel available. Between 8 a.m. and 4 p.m., if there were cases with ongoing procedures, there would be a care transition in which other anesthesia providers would take care of the patients.

Therefore, patients were randomly selected and categorized into three groups according to the start and end time of anesthesia, 1) daytime group, in which anesthesia was started and ended in the daytime period between 8 a.m. and 4 p.m., 2) care-transition group, in which anesthesia included a care transition between the daytime and after-hours period, and 3) after-hours group, in which anesthesia started and ended in the after-hours period between 4 p.m. and 8 a.m.

According to the anticipated lowest incidence rates during daytime hours and the highest incidence after-hours, the sample size allocation among the three groups was adjusted to a 3:2:1 ratio. The patients were selected through the anesthesia electronic database, with exclusions for public holidays and weekends. Each month, patients were chosen according to the sample size ratio, with the initial 60 cases from daytime procedures assigned to Group 1, the initial 40 cases from care-transition procedures allocated to Group 2, and the initial 20 cases from after-hours procedures assigned to Group 3. Over a 12-month period, the total numbers of patients were 720 patients in Group 1, 480 in Group 2, and 240 in Group 3. Subsequently, patients were randomly chosen to reach the target numbers for each group at 600 for the daytime group, 400 for the care-transition group, and 200 for the after-hours group (Figure 1).

Data collection

The patients' demographic data, surgical-related, anesthesia data, and anesthesia-related adverse events were reviewed and extracted from the hospital

electronic records and anesthesia departmental database.

Demographic data collected were gender, age, body weight, height, ASA classification, and pre-existing medical diseases such as hypertension, diabetes mellitus, dyslipidemia, chronic kidney disease, coronary artery disease, chronic obstructive pulmonary diseases, and preexisting arrhythmia. Surgical-related and anesthesia-related data collected were region of operations/procedures, emergency surgery, choice of anesthesia, duration of anesthesia, estimated blood loss, urine output, fluid balance, intraoperative blood transfusion, intraoperative vasopressor administration, and postoperative dispatch.

According to the region of operations/procedures, the authors categorized regions of operations as general surgery including hepatobiliary, colorectal, minimal invasive, vascular, urological, plastic, and acute care surgery, obstetric and gynecologic surgery, non-operating room anesthesia (NORA) procedures including endoscopy, electroconvulsive treatment, radio intervention, and cardiac catheterization and/or intervention, orthopedic surgery, neurosurgery, cardiovascular thoracic surgery, ear nose throat surgery, trauma surgery, and others

Anesthesia-related adverse events were grouped according to organ systems that included cardiovascular system for cardiac arrest, myocardial infarction, arrhythmia, and shock, neurological system for stroke and convulsion, respiratory system for respiratory failure, airway-related adverse events for failed intubation, difficult intubation, airway-related reintubation, esophageal intubation, dental injury, and lip trauma, regional anesthesia-related for nerve injury, total spinal block, and post dural puncture headache, and others such as drug error, transfusion mismatch, anaphylaxis, awareness, and equipment malfunction, which was defined as anesthesia departmental criteria, and recorded by anesthesia personnel. Adverse anesthesia events reported by the Department of Anesthesiology at Siriraj Hospital will be self-reported by the anesthesia personnel. The included events occurred intraoperatively and within 24 hours postoperatively and were recorded by the nurse anesthetists during the visits the day after surgery. The visiting nurse anesthetists would inform the patient's caregiver in the operating room about any adverse events for prompt treatment, follow-up, and documentation in Siriraj Hospital's system.

Sample size calculation

The required sample size calculation was based on an adverse anesthesia events incidence of 1.0% in the daytime and 4.2% in the after-hours period as reported in a previous study[11]. The estimation of sample size for the chi-square test for multiple proportions with unequal sample sizes, was performed using nQuery Advisor (2017). A significance level of 5%, power of 80%, and estimated proportions of adverse anesthesia events incidence at 1%, 3%, and 5% in groups 1, 2, and 3 were considered. Given the low incidence of adverse anesthesia events in the daytime group, an allocation ratio of 3:2:1 was utilized for groups 1, 2, and 3. Additionally, a 15% dropout allowance was factored in and rounded up for allocation purposes. Consequently, the final sample size was set at 1,200, comprising 600, 400, and 200 patients in groups 1, 2, and 3, respectively.

Statistical analysis

Due to abnormal distribution, continuous data were analyzed as the median and interquartile range (IQR), while categorical data were analyzed as the number (n) and percentage (%). Comparison of the categorical data were performed using the chi-square or Fisher's exact test. Comparisons of the continuous data were performed using the Kruskal-Wallis test. The incident of anesthesia-related adverse events in patients undergoing surgery at different times of the day were compared using chi-square. The factors associated with adverse anesthesia events were identified through multiple logistic regression analysis. The time of anesthesia was incorporated as a variable in the multiple logistic regression model. The data were categorized as follow: age 65 years or more, body mass index (BMI) of 25 or more kg/m^2, ASA classifications III-IV, more than two underlying diseases, duration of anesthesia of more than four hours, urine output of less than 0.5 mL/kg/hour, and positive fluid balance greater than 10 mL/kg.

Risk factors with a univariable p-value of less than 0.2 were entered into a multiple logistic regression model. The crude odds ratio (OR) and adjusted odds ratio, with 95% confidence interval (CI), were reported. The analyses were performed using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA). A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

One thousand two hundred patients were

Table 1. Demographic data

Characteristic	All (n=1,200, 100%)	Daytime (n=600, 50%)	Care transition (n=400, 33.3%)	After-hours (n=200, 16.7%)	p-value
Sex: male; n (%)	548 (45.7)	267 (44.5)	198 (49.5)	83 (41.5)	0.129
Age (year); median (IQR)	57.0 (40.0, 69.0)	58.0 (40.0, 68.0)	57.0 (42.0, 68.8)	57.5 (40.0, 71.0)	0.949
BMI (kg/m^2); median (IQR)	23.8 (20.9, 27.0)	24.3 (21.0, 27.8)	23.8 (20.9, 27.6)	25.0 (21.8, 27.5)	0.684
ASA classification III-IV; n (%)	439 (36.6)	205 (34.2)	150 (37.5)	84 (42.0)	0.123
Underlying disease; n (%)					
Hypertension	506 (42.2)	254 (42.3)	178 (44.5)	74 (37.0)	0.213
Dyslipidemia	270 (22.5)	140 (23.3)	89 (22.3)	41 (20.5)	0.700
Diabetes mellitus	238 (19.8)	127 (21.2)	71 (17.8)	40 (20.0)	0.413
Chronic kidney disease	138 (11.5)	82 (13.7)	42 (10.5)	14 (7.0)	0.028*
Coronary artery disease	103 (8.6)	45 (7.5)	35 (8.8)	23 (11.5)	0.214

BMI=body mass index; ASA=American Society of Anesthesiologists; IQR=interquartile range

Table 2. Surgical and anesthesia-related data

Characteristic	All (n=1,200, 100%)	Daytime (n=600, 50%)	Care transition (n=400, 33.3%)	After-hours (n=200, 16.7%)	p-value
Emergency surgery; n (%)	119 (9.9)	31 (5.2)	30 (7.5)	58 (29.0)	<0.001*
Region of operation; n (%)					<0.001*
General surgery	473 (39.4)	220 (36.7)	170 (42.5)	83 (41.5)	
Obstetric gynecologic surgery	181 (15.1)	90 (15.0)	45 (11.3)	46 (23.0)	
NORA procedures#	135 (11.3)	97 (16.2)	19 (4.8)	19 (9.5)	
Orthopedic surgery	103 (8.6)	46 (7.7)	45 (11.3)	12 (6.0)	
Neurosurgery	91 (7.6)	34 (5.7)	47 (11.8)	10 (5.0)	
Cardiovascular thoracic	68 (5.7)	26 (4.3)	28 (7.0)	14 (7.0)	
Ear nose throat	64 (5.3)	32 (5.3)	28 (7.0)	4 (2.0)	
Trauma	56 (4.7)	36 (6.0)	12 (3.0)	8 (4.0)	
Other	29 (2.4)	19 (3.2)	6 (1.5)	4 (2.0)	
Choice of anesthesia; n (%)					<0.001*
General anesthesia (GA)	802 (66.8)	380 (63.3)	297 (74.3)	125 (62.5)	
Regional anesthesia (RA)	179 (14.9)	94 (15.7)	40 (10.0)	45 (22.5)	
Combined GA with RA	53 (4.4)	18 (3.0)	33 (8.3)	2 (1.0)	
Total intravenous anesthesia	101 (8.4)	78 (13.0)	13 (3.3)	10 (5.0)	
Other	65 (5.4)	30 (5.0)	17 (4.3)	18 (9.0)	
Duration of anesthesia (minutes); median (IQR)	195 (105, 301)	106 (70, 165)	285 (195, 404)	100 (70, 150)	<0.001*
Team includes trainee; n (%)	1,035 (86.3)	500 (83.3)	366 (91.5)	169 (84.5)	0.001*
Estimated blood loss (mL); median (IQR)	200 (40, 500)	100 (20, 400)	310 (100, 688)	300 (28-500)	<0.001*
Urine output (mL/kg/hour); median (IQR)	1.4 (0.8, 2.4)	1.4 (0.7, 2.5)	1.4 (0.9, 2.3)	1.4 (0.7, 2.4)	0.009*
Fluid balance (mL); median (IQR)	643 (230, 1208)	370 (150, 640)	728 (319, 1442)	338 (150, 753)	<0.001*
Intraoperative blood transfusion; n (%)	176 (14.7)	53 (8.8)	89 (22.3)	34 (17.0)	<0.001*
Intraoperative vasopressor infusion; n (%)	92 (7.7)	28 (4.7)	42 (10.5)	22 (11.0)	<0.001*

NORA=non-operating room anesthesia; IQR=interquartile range

Non-operating room procedures, including endoscopy, electroconvulsive treatment, radio intervention, and cardiac intervention

included in the present study, with a similar proportion of males to females at 45.7% versus 54.3% (p=0.842). The overall median age and BMI were 57 years old and 23.8 kg/m^2, respectively. Most patients (63.4%) were in ASA classification I or II. The patients' demographic data and existence of pre-existing medical diseases were comparable among the three groups (Table 1). The surgical-related and anesthesia data are shown in Table 2. Emergency cases were the most common in the after-hours period at 29% (p<0.001). The types of surgery categorized by area of surgery were general surgery, which included

Table 3. Incidence of overall anesthesia-related adverse events

Anesthesia-related adverse events	All (n=1,200, 100%); n (%)	Daytime (n=600, 50%); n (%)	Care transition (n=400, 33.3%); n (%)	After-hours (n=200, 16.7%); n (%)	p-value
Over all adverse events	64 (5.3)	40 (6.7)	14 (3.5)	10 (5.0)	0.090
Cardiovascular system	10 (0.2)	7 (1.2)	1 (0.3)	2 (1.0)	0.284
Cardiac arrest	5 (0.4)	4 (0.7)	0 (0.0)	1 (0.5)	
Myocardial infarction	1 (0.1)	0 (0.0)	1 (0.3)	0 (0.0)	
Arrhythmia	3 (0.3)	2 (0.3)	0 (0.0)	1 (0.5)	
Shock	1 (0.1)	1 (0.2)	0 (0.0)	0 (0.0)	
Respiratory system	6 (0.1)	4 (0.7)	0 (0.0)	2 (1.0)	0.187
Respiratory insufficiency/failure	6 (0.1)	4 (0.7)	0 (0.0)	2 (1.0)	
Neurological system	1 (0.1)	0 (0.0)	1 (0.3)	0 (0.0)	0.368
Stroke	1 (0.1)	0 (0.0)	1 (0.3)	0 (0.0)	
Airway-related complication	41 (0.6)	23 (3.8)	12 (3.0)	6 (3.0)	0.212
Difficult intubation	18 (1.5)	12 (2.0)	6 (1.5)	0 (0.0)	
Esophageal intubation	3 (0.3)	2 (0.3)	1 (0.3)	0 (0.0)	
Airway obstruction	4 (0.3)	1 (0.2)	2 (0.5)	1 (0.5)	
Dental injury	3 (0.3)	1 (0.2)	1 (0.3)	1 (0.5)	
Lip trauma	13 (1.1)	7 (1.2)	2 (0.5)	4 (2.0)	
Regional anesthesia-related	1 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)	0.606
Post dural puncture headache	1 (0.1)	1 (0.2)	0 (0.0)	0 (0.0)	
Other	5 (0.1)	5 (0.8)	0 (0.0)	0 (0.0)	0.081

head-neck, vascular, colorectal, hepatobiliary, minimal invasive, acute care, urologic, and plastic surgery. Orthopedic surgeries were the most common operations and were comparable in each group. NORA procedures were the third-highest procedures and were highest in the daytime group compared to the other groups at 16.2% in the daytime, 4.8% in the care-transition, and 9.5% in the after-hours groups.

General anesthesia was performed in 66.8% of the patients followed by regional anesthesia in 14.9%, with 86.3% involving an anesthesia trainee, who were typically anesthesia residents or nurse anesthetist students. The duration of anesthesia, positive fluid balance, intraoperative blood transfusion, and intraoperative vasopressor infusion were higher in the care-transition group (p<0.001). Patients who undergone anesthesia in daytime period had higher number of patients who were dispatched to post anesthetic care unit, while patients in care transition group had many patients with planned intensive care unit (ICU) admission, while the number of patients with unplanned ICU admission was higher in the after-hours group.

The overall incidence of anesthesia-related adverse events was 5.3%, for 64 patients. There was no significant difference in the incidence of anesthesia-related adverse events in the daytime, care-transition, and after-hours groups, which were 6.7%, 3.5%, and 5.0%, respectively (p=0.090) (Table 3, Figure 2). The anesthesia-related adverse events in the three groups are shown in Table 3. The most common complication in all groups was airway-related complication at 3.8%, 3.0%, and 3.0%, respectively. Difficult intubation was the most common adverse anesthesia events in the daytime and care transition groups at 2% and 1.5%, respectively. Lip trauma was the most common complication in the after-hours period at 2%. Cardiac arrest was higher in the daytime and after-hours periods at 0.7% and 0.5%, respectively. The 24-hour mortality was zero in the present study.

The only significant factor associated with anesthesia-related adverse events was the type of surgery (Table 4), namely NORA procedures (OR 5.97, 95% CI 2.94 to 12.13, p<0.001). The time of anesthesia had not been shown to be an independent risk factor for adverse anesthesia events (OR 0.98, 95% CI 0.47 to 2.06, p=0.956).

Discussion

The incidence of anesthesia-related adverse events in the after-hours period was 5%, which was not significantly different from the anesthesia-related adverse events in the daytime group at 6.7% and care-transition group at 3.5%, p=0.090. The present study result was inconsistent with the hypothesis that

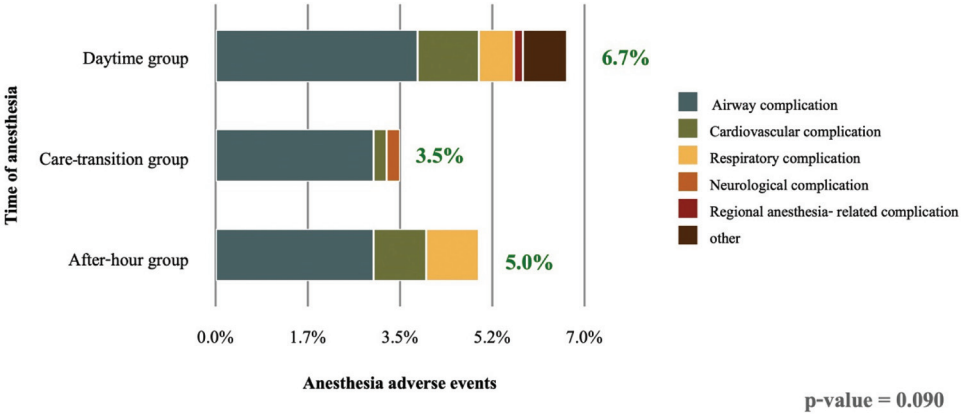

Figure 2. Incidence of anesthesia-related adverse events in patient under different time of anesthesia.

Table 4. Factor associated with the anesthesia-related adverse events

Factor	With event (n=64, 5.3%); n (%)	Without event (n=1,136, 94.7%); n (%)	p-value	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age ≥65 years	17 (26.6)	390 (34.3)	0.202				
Sex: male	32 (50.0)	516 (45.4)	0.474				
BMI ≥25 kg/m^2	24 (38.7)	430 (39.2)	0.934				
ASA classifications III-IV	18 (28.1)	421 (37.1)	0.149	1.51 (0.86 to 2.63)	0.151	0.57 (0.31 to 1.05)	0.069
Underlying diseases >2	11 (17.2)	204 (18.0)	0.876				
Emergency surgery	5 (7.8)	114 (10.0)	0.563				
Time of anesthesia			0.090				
Day time	40 (62.5)	560 (49.3)					
Care transition	14 (21.9)	386 (34.0)		1.36 (0.67 to 2.77)	0.401	0.74 (0.35 to 1.55)	0.427
After-hours	10 (15.6)	190 (16.7)		0.69 (0.30 to 1.58)	0.379	0.98 (0.47 to 2.07)	0.956
Region of operation			<0.00				
General surgery	16 (25.0)	457 (40.2)	1				
Obstetric gynecologic surgery	7 (10.9)	174 (15.3)		1.43 (0.16 to 12.74)	0.749	0.90 (0.36 to 2.28)	0.826
Orthopedic surgery	5 (7.8)	98 (8.6)		6.05 (0.79 to 46.69)	0.084	1.45 (0.52 to 4.08)	0.482
Neurosurgery	5 (7.8)	86 (7.6)		1.13 (0.13 to 9.51)	0.913	1.94 (0.67 to 5.61)	0.220
Cardiovascular thoracic	2 (3.1)	66 (5.8)		0.98 (0.13 to 7.66)	0.985	1.39 (0.292 to 6.63)	0.678
Ear nose throat	1 (1.6)	63 (5.5)		0.85 (0.074 to 9.74)	0.895	0.43 (0.06 to 3.34)	0.421
Trauma	3 (4.7)	53 (4.7)		0.44 (0.03 to 7.36)	0.571	1.675 (0.47 to 6.01)	0.429
Non-operating room procedures#	24 (37.5)	111 (9.8)		1.59 (0.16 to 15.95)	0.696	5.97 (2.94 to 12.13)	<0.001*
Other	1 (1.6)	28 (2.5)		1.63 (0.18 to 14.53)	0.663	0.84 (0.11 to 6.65)	0.869
Choice of anesthesia			0.298				
General anesthesia (GA)	39 (60.9)	763 (67.2)					
Regional anesthesia (RA)	10 (15.6)	169 (14.9)					
Combined GA with RA	1 (1.6)	52 (4.6)					
Total intravenous anesthesia	9 (14.1)	92 (8.1)					
Other	5 (7.8)	60 (5.3)					
Duration of anesthesia >4 hours	12 (18.8)	330 (29.0)	0.076	1.77 (0.94 to 3.37)	0.079	0.95 (0.42 to 2.15)	0.907
Team included anesthesia trainee	51 (79.7)	984 (86.6)	0.117	1.65 (0.88 to 3.10)	0.121	0.91 (0.46 to 1.79)	0.787
Urine output <0.5 mL/kg/hour	7 (10.9)	107 (9.4)	0.687				
Positive fluid balance >10 mL/kg	17 (26.6)	407 (35.8)	0.131	1.54 (0.88 to 2.72)	0.134	1.10 (0.57 to 2.12)	0.778
Intraoperative blood transfusion	4 (6.3)	172 (15.1)	0.050	2.68 (0.96 to 7.46)	0.060	0.49 (0.16 to 1.48)	0.205
Intraoperative vasopressor infusion	3 (4.7)	89 (7.8)	0.473				

BMI=body mass index; ASA=American Society of Anesthesiologists; OR=odds ratio; CI=confidence interval

Non-operating room procedures, including endoscopy, electroconvulsive treatment, radio intervention, and cardiac intervention

* Statistical significance, p<0.05

anesthesia services in the after-hours or nighttime period could be correlated with higher surgical and adverse anesthesia events. In term of the anesthesia personnel, the Perioperative and anesthetic adverse events in Thailand (PAAd Thai) study identified the most frequent contributing factors to adverse anesthesia events were inexperience, inadequate preanesthetic evaluation, inappropriate decisions, and haste[7], which may all be increased in the after-hours services compared to in daytime services. Another previous literature study reported that anesthesia in the after-hours period was associated with a decrease in anesthetic skills[7] and decision-making skills for patient management[12].

The low incidence of adverse anesthesia events in the after-hours group may be attributed to multiple factors. For instance, over 70% of cases during after-hours were non-emergencies, since Siriraj Hospital is a medical school and tertiary facility with constrained operating room capacity. Various non-urgent procedures, such as hemorrhoidectomy, second look surgery, or vacuum dressing changes, were commonly performed during after-hours with patients who had been appropriately prepared prior to surgery. Since urgent and emergency surgeries contribute to higher risks for adverse anesthesia events[13], a lower than expected number of emergency surgeries in the after-hours group could lead to a non-significant difference in the incidence of adverse anesthesia events among the groups.

Although the definition of anesthesia-related adverse events was shown in the anesthetic record forms, the variety of recorders could cause uncertain adverse anesthesia events reporting. Other causes might be from the self-reporting system for the occurrences of events and biased documentation, which could have caused the after-hours incidence to be as same as the other periods. Studies have acknowledged that the incident report system had problems[14,15]. The previous review had elucidated barrier of incident report system such as uncertain of what to report, attitudes towards adverse anesthesia events reporting, inadequate trained staff, and most of the incident were reported by nurse over physicians[14,15]. As previously mentioned, the reporting of adverse anesthesia events at the Department of Anesthesiology at Siriraj Hospital includes both self-reporting and follow-ups conducted by visiting nurse anesthetists to guarantee comprehensive monitoring of adverse anesthesia incidents. Despite these measures, there are still areas available for enhancing the reporting system, particularly for intraoperative events in the after-hours period. Accordingly, the personnel responsible for the occurrence record system should be trained, as well as all the anesthesia personnel and occurrence report system itself should be regularly evaluated.

However, the occurrence rate of anesthesia-related adverse events during after-hours resembled that of a prior study[11]. The lack of a significant difference in the primary outcome could be attributed to the higher incidence observed during daytime anesthesia. The increased incidence of adverse anesthesia events in the daytime group could be multifactorial, with perioperative morbidity and mortality associated with anesthesia being influenced by factors such as patient characteristics[1], surgical factors[2,4], and anesthetic factor itself[3].

The factors associated with the anesthesia-related adverse events were determined in the overall patient cohort since the incidences of adverse anesthesia events in each group were low. NORA services were linked to a higher risk of anesthesia-related adverse events, potentially contributing to the highest incidence of adverse anesthesia events in the daytime group. These findings emphasized the significance of NORA, which often involve a multitude of challenges such as a high patient volume, fast-paced workflow, simple and complex procedures, older or younger, healthy and sick patients, limited equipment, sedation, unfamiliar environments and procedures, inadequate assistance, and lack of experience[16-19]. However, there was still controversy whether NORA increase rates of morbidity and mortality compared with operating room[16,17], necessitating further investigation.

On the contrary, a study concluded that surgical procedures were equally safe across different times during the workday, week, or month. However, a direct comparison with the present study is inconclusive as the previous study excluded emergency cases and surgeries conducted during nighttime[9].

Overall, there were 64 anesthesia-related adverse events. The most common adverse anesthesia events in the present study were difficult intubation, lip trauma, and cardiac arrest, respectively. PAAd Thai study[7] found the most common complications were cardiac arrest, death, reintubation, esophageal intubation, and difficult intubation, similar to the present study. While the most common complications in the previous study that compare complication in daytime and after-hours period[11] were pain and nausea vomiting, which were not considered

as anesthetic complications in the current study. In addition to the different definitions of adverse anesthesia events, Siriraj Hospital is a tertiary hospital with complicated surgeries and patients. Being a medical school with medical students and resident training whose inexperience and lack of skill combine with complicated patients, difficult intubation and lip trauma can be expected as the most common anesthesia-related adverse events. Airway-related adverse events are well known to be the most common adverse anesthesia events[5].

The present research was based on a retrospective design, which could have led to limitations due to incomplete recording in the database or missing data or a low incidence. The previous study[11] reported a 1.0% incidence in daytime period compared to the 6.7% incidence shown in the present study, potentially resulting in an insufficient sample size to reveal a significant difference in the incidence of adverse anesthesia events among the groups. Subsequent studies involving larger sample sizes are advised.

The risks related to adverse anesthesia events within each group could not be thoroughly examined. Only one factor could be identified as an independent risk factor of the adverse anesthesia events across all the patients. Given that the sample size was not determined for multiple logistic regression analysis, further studies will be necessary to investigate this aspect. Furthermore, the reported incidents of anesthesia adverse anesthesia events may not accurately reflect the true incidence of such events due to potential misreporting, which also represents a limitation of the study design. Despite the effectiveness of the incident report system at Siriraj Hospital, enhancements to the system are required for the improvement of quality and safety in anesthesia practices.

Conclusion

The present study is unable to demonstrate a significant difference in the incidences of anesthesia-related adverse events across various anesthesia periods. This result was not in line with the original hypothesis that a higher incidence of complications would be related to the after-hours period.

What is already known on this topic?

Adverse anesthesia events are related with human factors such as inexperience, inappropriate decisions, and haste, which are prominent in nighttime service.

What does this study add?

Anesthesia in the after-hours period does not relate to increase adverse anesthesia events.

Anesthesia outside of operating rooms (NORA) or remote anesthesia is associated with an increased occurrence of adverse anesthesia events.

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Conflicts of interest

The authors declare no conflict of interest.

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