Original Article

Perioperative and Anesthesia Adverse Events in Thailand [PAAd Thai] Incident Reporting Study: Unplanned ICU Admission Analysis

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Objective: To study of anesthetic outcomes and patient characteristics, events, and factors to determine the risks related to unplanned intensive care unit [ICU] admission after anesthesia.

Materials and Methods: The present study was a part of the Perioperative and Anesthetic Adverse events in Thailand [PAAd Thai] study. This is a prospective observational study analysis of structured case record form. Data collection was conducted in 22 hospitals across Thailand between January and December 2015. Baseline characteristics, details of anesthesia, type of procedure, and adverse events were recorded and analyzed to determine risks related to unplanned ICU admission after anesthesia.

Results: Rate of unplanned ICU admission was 4.3:10,000 anesthetic procedures. Cardiac arrest within 24 hours post-anesthesia had highest relative risk of 9.36. The other significant factors were elder age, duration longer than 120 minutes, higher ASA physical status (III, IV, V), overtime, emergency procedure, cardiac surgery, general surgery, vascular surgery, desaturation within 24 hours post-anesthesia, reintubation within 24 hours post-anesthesia, neurological complication within 24 hours post-anesthesia, myocardial ischemia within 24 hours post-anesthesia, and cardiac arrest within 24 hours post-anesthesia. After risk adjustment, the significant predictive factors were higher ASA physical status (III, IV, V), long anesthetic duration (longer than 120 minutes), vascular surgery, reintubation within 24 hours post-anesthesia, and cardiac arrest within 24 hours post-anesthesia. Reintubation within 24 hours post-anesthesia had the highest odds ratio of 8.36.

Conclusion: The predictive factors for unplanned ICU admission after anesthesia in Thailand were higher ASA physical status (III, IV, V), long anesthetic duration (longer than 120 minutes), vascular surgery, reintubation within 24 hours post-anesthesia, and cardiac arrest within 24 hours post-anesthesia.

Keywords: Anesthesia, Complication, ICU admission, Intensive care unit, Unplanned admission

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Intensive care units [ICU] offer excellent care for the patients who need close observation and aggressive treatment. However, these precious resources are usually scarce, costly, and may not be beneficial for all patients[1,2]. The factors including patient conditions, procedural factors, predicted adverse events, and anesthetic factors must be pre-operatively evaluated by the caregiver team to predict the need for intensive care post-anesthesia[3]. Nevertheless, unplanned admission to ICU is common with an incidence rate around 7.2 per 10,000 cases in Thailand (February 2003 to January 2004)[4]. Critically-ill patients are usually identified as high risk and post-operative ICU admission ensued. Healthy patients, on the other hand, are usually identified as low risk and routine care is sufficient. The patients admitted to intensive units without prior prediction usually have borderline cardiovascular

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reserved or have adverse event during anesthesia. In the present study, the factors were evaluated to identify the risk factors and events that are usually overlooked.

Materials and Methods

The present report was a part of the Perioperative and Anesthetic Adverse events in Thailand [PAAd Thai] study host by the Royal college of Anesthesiologists of Thailand. Data were collected prospectively from 22 hospitals across Thailand between January 1 and December 31, 2015. The data was collected from the incident report form, designed by Royal College of Anesthesiologists of Thailand, filled by anesthetic personnel who attended the case[5,6]. All entries with adverse event were then gathered and reviewed. The data from patients with unplanned intensive unit admission was then separately analyzed. Patient characteristics, types of procedure, duration of anesthesia, choices of anesthesia, and adverse events were reviewed. To determine the risk factors, rates of unplanned ICU admission were compared between patient with specific characteristic group and reference group (i.e., the patients with any adverse event but without the characteristic of interest).

Statistical analysis

The present study was multi-center, prospective, observational study of 22 hospitals. The data was analyzed using commercially available SPSS program version 18.0 (Chicago, IL). Descriptive statistics were calculated for all variables of interest. Continuous measures were summarized using means and standard deviations [SDs], whereas categorical measures were summarized using counts and percentages. Comparing proportion between two groups was done by Chi-squared test. A *p*-value of less than 0.05 was indicated as statistically significant then presented as relative risk [RR], 95% confidence interval [CI]. The variable was performed by fitting multi-logistic regression model including all variables that had *p*-values less than 0.05

Table 1. Baseline characteristics and procedures

	Total (n = 2,000), n (%)		*p*-value	RR	95% CI
	Unplanned ICU (n = 143)	Others (n = 1,857)			
Male	85 (8.3)	939 (91.7)	0.052		
Overtime procedure	72 (13.2)	473 (86.8)	<0.001*	2.82	2.04 to 3.91
ASA stage III, IV, V (vs. I, II)	124 (11.3)	969 (88.7)	<0.001*	6.59	3.88 to 11.17
Emergency	93 (12.8)	633 (87.2)	<0.001*	3.33	2.38 to 4.66
Age >85 years	7 (16.7)	35 (83.3)	0.027*	2.40	1.20 to 4.81
Age >90 years	5 (45.5)	6 (54.5)	0.001*	6.55	3.36 to 12.77
Weight (kg), mean ± SD	52.15±19.40	54.49±22.00	0.219		
Height (cm), mean ± SD	151.25±31.62	153.37±25.37	0.393		
Duration >100 minutes	96 (8.3)	1,058 (91.7)	0.020*	1.51	1.06 to 2.14
Duration >120 minutes	91 (9.0)	922 (91.0)	0.001*	1.73	1.23 to 2.43
Procedure					
Cardiac	21 (16.9)	103 (83.1)	<0.001*	2.60	1.70 to 3.99
Electroconvulsive	0 (0.0)	2 (100)	>0.999		
Opthalmological	0 (0.0)	62 (100)	0.020*	-	-
Thoracic	11 (10.7)	92 (89.3)	0.153		
Endoscopic	3 (3.9)	74 (96.1)	0.258		
Orthopaedic	13 (4.8)	256 (95.2)	0.113		
C-section	1 (5.0)	19 (95.0)	>0.999		
General surgery	59 (9.5)	562 (90.5)	0.006*	1.56	1.13 to 2.15
Otorhinolaryngological	1 (0.9)	112 (99.1)	0.008*	0.12	0.02 to 0.83
Dental	0 (0.0)	23 (100)	0.404		
Gynecological	5 (4.0)	120 (96.0)	0.158		
Plastic	2 (5.0)	38 (95.0)	>0.999		
Diagnostic	0 (0.0)	7 (100)	>0.999		
Obstetric	0 (0.0)	52 (100)	0.049*	-	-
Urological	4 (4.1)	94 (95.9)	0.227		
Intervention Rx	2 (10.0)	18 (90.0)	0.65		
Minimal invasive	1 (5.6)	17 (94.4)	>0.999		
Vascular	14 (21.5)	51 (78.5)	<0.001*	3.23	1.97 to 5.29
Radiotherapy	0 (0.0)	2 (100)	>0.999		
Neurosurgery	13 (8.3)	144 (91.7)	0.567		

ICU = intensive care unit; RR = risk ratio or relative risk; 95% CI = 95% confidence interval; ASA = American Society of Anesthesiologists

* *p*-value <0.05

from the univariate analysis then presented as odds ratio [OR] and 95% CI.

Results

The 333,219 data entries were reviewed, and 2,206 incident reports were identified. One hundred forty-three unplanned ICU admissions were documented (4.3:10,000 cases). For patient characteristic, while sex and body weight did not seem to increase rate of unplanned ICU admission, age was found to be a significant risk factor with RR 2.4 when patient were older than 85 years (95% CI 1.20 to 4.81, $p = 0.027$), and RR 6.55 when patient were older than 90 years ($p = 0.001$, 95% CI 3.36 to 12.77). The American Society of Anesthesiologists [ASA] physical status was also determined as risk factor with the RR of 6.59 when comparing ASA III, IV, V with ASA I, II (95% CI 3.88 to 11.17, $p<0.001$) (Table 1, 2).

Emergency procedures increased risk for unplanned ICU admission. It went up to more than 3-fold compared to the electives (RR 3.33, 95% CI 2.38 to 4.66, $p<0.001$). Procedures that incurred overtime associated with increased risk when compared to regular hours (13.2% versus 4.7%, RR 2.82, 95% CI 2.04 to 3.91, $p<0.001$). Duration of anesthesia also posed risk that became significant when longer than 100 minutes (RR 1.51, $p = 0.020$, 95% CI 1.06 to 2.14). When examining the effects of types of procedure on unplanned ICU admission rates, it revealed that vascular and cardiac significantly increased risk with unplanned ICU admission rate; 21.5% (RR 3.23, 95% CI 1.97 to 5.29, $p<0.001$) of all patients undergone vascular surgery with any adverse event and 16.9% (RR 2.6, 95% CI 1.70 to 3.99, $p<0.001$) of all patients undergone cardiac surgery with any adverse event. General surgery was also found to increase risk (RR 1.56, 95% CI 1.13 to 2.15, $p = 0.006$) (Table 1).

Surprisingly, no adverse event during anesthesia and post-anesthetic care unit period was found to significantly increase incidence of unplanned

Table 2. Frequency by ASA physical status

ASA stage I to VI	Unplanned ICU	Others	%
ASA stage I	2	281	0.7
ASA stage II	13	575	2.2
ASA stage III	43	618	6.5
ASA stage IV	47	217	17.8
ASA stage V	34	134	20.2
ASA stage VI	0	3	0.0

ASA = American Society of Anesthesiologists; ICU = intensive care unit

Table 3. During anesthesia

Adverse event during anesthesia	Total (n = 2,000), n (%)		*p*-value	RR	95% CI
	Unplanned ICU (n = 143)	Others (n = 1,857)			
Pulmonary aspiration	0 (0.0)	28 (100)	0.258		
Pulmonary embolism	1 (7.7)	12 (92.3)	>0.999		
Esophageal intubation	1 (0.6)	170 (99.4)	<0.001*	0.08	0.01 to 0.54
Endobronchial intubation	0 (0.0)	24 (100)	0.41		
Desaturation	9 (2.9)	306 (97.1)	0.001*	0.36	0.18 to 0.70
Re-intubation	0 (0.0)	58 (100)	0.019*	-	-
Difficult intubation	0 (0.0)	145 (100)	0.001*	-	-
Failed intubation	0 (0.0)	13 (100)	0.617		
Total spinal block	0 (0.0)	2 (100)	>0.999		
Coma/CVA/convulsion	0 (0.0)	7 (100)	>0.999		
Nerve injuries	0 (0.0)	5 (100)	>0.999		
Transfusion mismatch	0 (0.0)	3 (100)	>0.999		
Suspected MI/ischemia	1 (5.0)	19 (95.0)	>0.999		
Severe arrhythmia	7 (1.7)	409 (98.3)	<0.001*	0.20	0.09 to 0.42
Cardiac arrest	7 (3.1)	218 (96.9)	0.013*	0.41	0.19 to 0.86
Death	3 (3.2)	90 (96.8)	0.133		
Suspected malignant hyperthermia	0 (0.0)	1 (100)	>0.999		
Anaphylaxis/anaphylactoid reaction	1 (1.6)	62 (98.4)	0.084		
Drug error	0 (0.0)	95 (100)	0.006*	-	-
Equipment malfunction/failure	0 (0.0)	46 (100)	0.073		
Suspected emergency delirium	0 (0.0)	2 (100)	>0.999		

ICU = intensive care unit; RR = risk ratio or relative risk; 95% CI = 95% confidence interval; CVA = cardiovascular accident; MI = myocardial infarction
* *p*-value <0.05

ICU admission. Moreover, the results also shown that patients with some events during anesthesia (i.e., esophageal intubation, desaturation, difficult intubation, re-intubation, severe arrhythmia, cardiac arrest, and drug error) had lower rate of unplanned ICU admission (Table 3, 4).

Table 4. Post-anesthetic care unit period

Adverse event in post-anesthetic care unit	Total (n = 2,000), n (%)		*p*-value
	Unplanned ICU (n = 143)	Others (n = 1,857)	
Pulmonary aspiration	0 (0.0)	1 (100)	>0.999
Pulmonary embolism	1 (25.0)	3 (75.0)	0.257
Esophageal intubation	0 (0.0)	0 (0.0)	-
Endobronchial intubation	0 (0.0)	0 (0.0)	-
Desaturation	4 (3.5)	109 (96.5)	0.125
Re-intubation	6 (5.6)	102 (94.4)	0.508
Difficult intubation	0 (0.0)	2 (100)	>0.999
Failed intubation	0 (0.0)	0 (0.0)	-
Total spinal block	0 (0.0)	0 (0.0)	-
Coma/CVA/convulsion	1 (10.0)	9 (90.0)	0.525
Nerve injuries	0 (0.0)	1 (100)	>0.999
Transfusion mismatch	0 (0.0)	2 (100)	>0.999
Suspected MI/ischemia	0 (0.0)	3 (100)	>0.999
Cardiac arrest	0 (0.0)	9 (100)	>0.999
Death	0 (0.0)	5 (100)	>0.999
Suspected malignant hyperthermia	0 (0.0)	0 (0.0)	-
Anaphylaxis/anaphylactoid reaction	0 (0.0)	14 (100)	0.617
Drug error	0 (0.0)	1 (100)	>0.999
Equipment malfunction/failure	0 (0.0)	0 (0.0)	-
Suspected emergency delirium	1 (7.1)	13 (92.9)	>0.999

ICU = intensive care unit; RR = risk ratio or relative risk; 95% CI = 95% confidence interval; CVA = cardiovascular accident; MI = myocardial infarction

In the 24-hours post-anesthesia period, some adverse events related to the risk for unplanned ICU admission were identified. For respiratory adverse event, desaturation, and re-intubation were found to significantly increase risk with relative risks of 3.57 (95% CI 1.50 to 8.46, $p = 0.023$) and 5.26 (95% CI 3.54 to 7.82, $p<0.001$), respectively. For cardiovascular event, myocardial ischemia, cardiac arrest, and death were identified as risk factors with relative risks of 4.08 (95% CI 1.76 to 9.49, $p = 0.014$), 9.36 (95% CI 6.92 to 12.66, $p<0.001$), and 10.38 (95% CI 7.55 to 14.29, $p<0.001$), respectively. Neurologic events (i.e., coma, cardiovascular accident [CVA], and convulsion) were also found to increase risk (RR 2.98, 95% CI 1.51 to 5.87, $p = 0.009$) while nerve injury was not found to be risk factor (Table 5).

Multivariate analysis were performed and the results were shown in Table 6. After risk adjusting, the independent factors which significantly contributed to risk for unplanned ICU admission were ASA greater than 2, duration longer than 120 minutes, vascular surgery, reintubation within 24 hours post anesthesia, and cardiac arrest within 24 hours post-anesthesia.

Discussion

Interpreting the results from the present study

Table 5. Within 24 hours post-anesthesia

Adverse event within 24 hours post-anesthesia	Total (n = 2,000), n (%)		*p*-value	RR	95% CI
	Unplanned ICU (n = 143)	Others (n = 1,857)			
Pulmonary aspiration	1 (50.0)	1 (50.0)	0.138		
Pulmonary embolism	1 (100)	0 (0.0)	0.071		
Desaturation	4 (25.0)	12 (75.0)	0.023*	3.57	1.50 to 8.46
Re-intubation	20 (33.3)	40 (66.7)	<0.001*	5.26	3.54 to 7.82
Awareness (during GA)	1 (10.0)	9 (90.0)	0.525		
Coma/CVA/convulsion	7 (20.6)	27 (79.4)	0.009*	2.98	1.51 to 5.87
Nerve injuries	1 (6.7)	14 (93.3)	>0.999		
Transfusion mismatch	0 (0.0)	0 (0.0)	-		
Suspected MI/ischemia	4 (28.6)	10 (71.4)	0.014*	4.08	1.76 to 9.49
Cardiac arrest	81 (33.1)	164 (66.9)	<0.001*	9.36	6.92 to 12.66
Death	92 (31.1)	204 (68.9)	<0.001*	10.38	7.55 to 14.29
Suspected malignant hyperthermia	0 (0.0)	0 (0.0)	-		
Anaphylaxis/anaphylactoid reaction	0 (0.0)	1 (100)	>0.999		
Drug error	0 (0.0)	2 (100)	>0.999		
Equipment malfunction/failure	0 (0.0)	2 (100)	>0.999		

ICU = intensive care unit; RR = risk ratio or relative risk; 95% CI = 95% confidence interval; GA = general anesthesia; CVA = cardiovascular accident; MI = myocardial infarction

* *p*-value <0.05

Table 6. Multiple logistic regression

Factor	B	S.E.	Wald	*p*-value	OR (95% CI)
Emergency	0.343	0.310	1.220	0.269	1.409 (0.767 to 2.587)
Overtime procedure	0.274	0.268	1.039	0.308	1.315 (0.777 to 2.225)
Age >90 years	1.416	0.865	2.681	0.102	4.120 (0.756 to 22.437)
ASA stage III, IV, V	1.088	0.357	9.268	0.002*	2.969 (1.473 to 5.981)
Duration >120 minutes	0.824	0.242	11.652	0.001*	2.280 (1.421 to 3.661)
Procedures					
Cardiac surgery	0.465	0.371	1.571	0.210	1.592 (0.769 to 3.293)
General surgery	0.202	0.251	0.644	0.422	1.223 (0.748 to 2.002)
Otorhinolaryngological	-1.811	1.105	2.686	0.101	0.163 (0.019 to 1.426)
Vascular surgery	0.970	0.439	4.886	0.027*	2.638 (1.116 to 6.234)
During anesthesia					
Esophageal intubation	-1.272	1.034	1.514	0.219	0.280 (0.037 to 2.127)
Desaturation	-0.395	0.417	0.893	0.345	0.674 (0.297 to 1.528)
Severe arrhythmia	-1.041	0.462	5.074	0.024*	0.353 (0.143 to 0.873)
Cardiac arrest	-1.183	0.438	7.311	0.007*	0.306 (0.13 to 0.722)
24 hours post-anesthesia					
Desaturation 3	1.003	0.745	1.812	0.178	2.726 (0.633 to 11.747)
Re-intubation 3	2.124	0.365	33.786	<0.001*	8.364 (4.087 to 17.118)
Coma/CVA/convulsion	1.031	0.535	3.708	0.054	2.804 (0.982 to 8.009)
Suspected MI/ischemia	1.111	0.690	2.594	0.107	3.037 (0.786 to 11.739)
Cardiac arrest	1.681	0.273	37.801	<0.001*	5.373 (3.144 to 9.184)
Constant	-4.508	0.413	119.384		

OR = odds ratio; 95% CI = 95% confidence interval; ASA = American Society of Anesthesiologists; CVA = cardiovascular accident; MI = myocardial infarction

* *p*-value <0.05

should be done with great caution. All entries were collected from data sheets designed for recording adverse event, thus data from patients with planned post-operative ICU admission was not included. Moreover, unplanned admission per se cannot be totally considered as true complication as some patients are admitted just for observation, hospital policy[7], or by judgment of the caregiver, which usually become less scrutiny after complication. Identified risk factors from this study did not reflect severity of patients or suitability of the criteria used and could not simply be used to judge if a patient should be admitted or not. These factors may deserve more attention or were overlooked.

Elder age[8] and ASA physical status, both frequently presumed risk factors are usually important when planning for peri-operative care. However, after adjusting for other factors, age became insignificant while ASA physical status was shown to have some significance. The result supported that physiological age is more important than chronological age.

Charuluxananan et al had reported some high risk of procedures in Thailand, which were neurosurgery, otolaryngological, urological, and cardiac surgery[9]. In the present study, after multivariate analysis, only vascular surgery was associated with unplanned ICU admission. This may partly due to usually planned ICU admission for most cardiac surgery, which were less frequent for vascular surgery but can also be a reason of risk underestimation for vascular surgery patients as well. Contrary to common beliefs, neither emergency nor overtime procedure contributed to the risk. Longer anesthetic duration was the only procedural factor that increased the risk.

Leigh and Tytler had reported cardiovascular event during procedure and respiratory event during recovery period as major causes for unplanned ICU admission[10]. In contrast, this study found that some specific events during anesthetic period were associated with decreased risk of unplanned ICU admission. Severe arrhythmia and cardiac arrest during anesthesia were found to significantly associate with the decreased risk (see Table 3). This finding might be due to high mortality rate of the complications themselves which, in this study, were 3.4% and 40.4% for severe arrhythmia and cardiac arrest during anesthesia respectively. This resulted in less survivors to be able to be transferred to ICU. More serious adverse events also tend to occur in more fragile patients, which made intensive care already anticipated and prepared.

Patients admitted to the ICU following initial standard ward admission had high rate of mortality[11]. In the present study, adverse events during post-anesthetic 24 hours period were found to have highest

odds ratio for unplanned ICU admission. Re-intubation was of the most important with odds ratio of 8.364 followed by cardiac arrest with odds ratio of 5.373. Neurologic adverse event was not found to contribute to the risk. This finding was similar to study of Rose et al on patients admitted to ICU for mechanical ventilation and had reported neurologic problems as a rare cause in unplanned group[12]. However, this may partly due to categorization of the complications that categorized coma, convulsion, and CVA in one category. CVA and coma are more serious complications that usually require specific care, close observation, and prompt treatment. Convulsion, on the other hand, may vary depending on the causes, and may treated outside intensive care. When combined into one category, the result might be misleading.

Limitation

All of the data collected were from only 22 hospitals, which might not represent all the hospitals in Thailand. Each hospital also varied in ICU admission protocols and capability of routine care at ward. Moreover, some hospitals had step down ward that would reduce the need for ICU. More detailed data or recruiting more hospitals would improve accuracy of the results.

Conclusion

After adjusted for other factors, the predictive factors for unplanned ICU admission after anesthesia in Thailand were higher ASA (more than 2), long anesthetic duration (longer than 120 minutes), vascular surgery, reintubation within 24 hours post-anesthesia, and cardiac arrest within 24 hours post-anesthesia.

What is already known on this topic?

The incidence of unplanned ICU after anesthesia was reported to be around 7.2:10,000 cases between February 2003 and January 2004 in Thailand.

What this study adds?

The incidence of unplanned ICU after anesthesia in Thailand was decreased to 4.3:10,000 cases. Some factors that associate with the incidence had been identified.

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Potential conflicts of interest

The authors declare no conflict of interest.

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