The Incidence, Characteristics, and Outcomes of Stroke and Seizure In Critically Ill Surgical Patients: A Multicenter Cohort Study of Thai Surgical Intensive Care Units (THAI-SICU Study)

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Objective: *To explore the incidence, characteristics, and outcomes of patients affected with new onset of stroke and seizure in the surgical intensive care unit (SICU).*
Material and Method: *This study identified new onset of stroke and seizure in 4,652 patients admitted to our multicenter prospective cohort study, a collaboration of nine university-affiliated surgical ICUs in Thailand between April 2011 to January 2013.*
Results: *The authors found new stroke and seizure events at 0.2% and 1%, respectively. The significant characteristics found in stroke and seizure patients included: reason for ICU admission, American Society of Anesthesiologists (ASA) physical status classification, and severity of patients at ICU admission (evaluated by APACHE-II and SOFA day score in first 24 hours of ICU admission). In terms of outcomes, there was higher ICU mortality in both stroke and seizure groups than in non-stroke and non-seizure groups (18% vs. 36% vs. 9%, p<0.001, respectively). In addition, ICU length of stay among stroke and seizure patients was also longer than non-stroke and non-seizure groups (6 (4-18) vs. 10 (4-16) vs. 2 (1-4) days, p<0.001, respectively). However, multivariable regression analysis showed a statistical significance only in longer duration of ICU stay in stroke (6.07 days; 95% CI: 3.34-8.80) and seizure (3.88 days; 95% CI: 2.15-5.62) when compared with non-stroke and non-seizure patients, adjusted by ASA, APACHE-II and SOFA score).*
Conclusion: *From Thai-SICUs study, patients admitted to surgical ICU who developed new episodes of stroke and seizure had longer ICU length of stay when adjusted by their severity score.*

Keywords: *Stroke, Seizure, Surgical intensive care unit, Mortality rate, ICU length of stay*

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Although a low incidence of perioperative stroke and seizure following general non-cardiac surgery has been reported[1,2], those affected deserve more attention because they have serious disability sequelae and a greater risk of hospital mortality than post-operative patients with non-neurological complications who underwent surgery[1,3]. In addition, none of the study collecting data about stroke and seizure episodes, particularly in critically ill patients, were admitted to surgical intensive care units. For this reason, the authors focused on neurological complications, particularly new onset of stroke and seizure, by using a large nationwide multicenter study-the Thai-SICU study-to identify incidence of stroke and seizure, characteristics, and outcomes of non-cardiac surgical patients admitted to our surgical intensive care units (ICUs).

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Material and Method

A total of 4,652 patients were enrolled in the

Thai surgical intensive care unit (Thai-SICU) multi-center study, this study was a collaboration of nine university-affiliated surgical intensive care units (ICUs) in Thailand. Daily prospective data collection for 28 days of ICU admission, or until ICU discharge, if occurring earlier, was collected from April 2011 to January 2013. The study protocols were submitted to and approved by individual ethics and research committees at each participating institution.

Data collection

Patient age, sex, pre-existing co-morbidities, reason for ICU admission, smoking status, the American Society of Anesthesiologists (ASA) physical status classification, surgical status leading to ICU admission (including emergency and elective operation), surgical site of operation, severity at ICU admission (evaluated by APACHE-II and SOFA day-1 score) were collected. New cases of stroke and seizure were screened daily during ICU stay up to a maximum of 28 days, or until ICU discharge. When these conditions occurred, more information about affected patients, and medical personnel, who provided the diagnoses, was recorded. In addition, type of stroke including infarction or hemorrhage was classified, whereas seizure was recorded according to whether it was refractory or not, focal or generalized, and potential causes that triggered seizure. All treatment modalities (especially medications provided), surgical intervention (if advanced), and the result of neurological status at ICU discharge were also collected.

To determine patient outcomes, we evaluated SICU mortality, 28-day hospital mortality (calculated from the first date of SICU admission), length of ICU stay and length of hospital stay. Data were compared between stroke, seizure, and non-stroke and non-seizure patient groups and analyzed by statistical methods.

Definitions

"New onset of stroke" was defined as a new diagnosis of cerebrovascular accident occurring after the ICU admission including both cerebral infarction and hemorrhage[4].

"Seizure" was diagnosed based on abnormal and involuntary movement evidenced by clinical observation or electroencephalographic presentation of muscular contractions or inhibitions[4].

"Status epilepticus" is generally defined by the occurrence of a single, unremitting seizure with a duration longer than 5 to 10 minutes or frequent clinical seizures without an inter-ictal return to the baseline clinical state[4].

"Refractory status epilepticus" was defined as ongoing seizures following first- and second-line drug therapy[4].

Statistical analysis

Cohort data were presented by frequency and percentage when there were nominal and categorical data. For continuous data, they were shown as median and interquartile range. Categorical data were analyzed by Fisher's exact test and continuous data were analyzed by Kruskall-Wallis test. Statistical significance was considered when *p*-value was less than 0.05. Multivariable logistic regression analysis for adjusting outcomes (including ICU mortality, 28-day hospital mortality, length of ICU and length of hospital stay) with patients' severity scores composed of ASA status, APACHE-II, and SOFA score. The authors used STATA, version 11.0 (STATA Inc., College Station, TX) for statistical analysis.

Results

The incidence of new episodes of stroke was at 0.2% (11 cases) and seizure at 1% (45 cases). Mean age, sex, and pre-existing co-morbidities were the same in these three groups. On the other hand, primary diagnosis at admission, ASA classification, and surgical status, at ICU admission showed statistically significant differences. Patient severity score (both SOFA and APACHE-II score) were higher in stroke and seizure than non-stroke and non-seizure group, SOFA score at 4 (2-6) versus 8 (5-11) versus 2 (1-5), $p<0.001$, APACHE-II score at 11 (8-18) versus 19 (14-28) versus 10 (7-15), $p<0.001$, respectively (Table 1 and Fig. 1).

Table 2 shows information about stroke. The authors found cerebral infarctions were the most common causes (7 cases from 10 known cases of stroke), with weakness of extremities were the most common presentation. Nurses were the first to detect this abnormal symptom; however, ICU attending physicians made definitive stroke diagnoses. At discharge, most stroke patients had nearly fully recovered and were able to perform independent activities of daily life as evaluated by cerebral performance category score (CPC 1&2).

This study found 45 cases with seizure (Table 3), however only 42 cases had available details. Generalized seizure was more common than partial seizure (24 cases and 12 cases, respectively). Over half of cases had status epilepticus (23 cases), and one

Table 1. Characteristics of surgical intensive care patients with stroke and seizure in Thai-SICU study

Characteristics	None (n = 4,596)	Stroke (n = 11)	Seizure (n = 45)	*p*-value
Age, years (mean ± SD)	64 (51-75)	70 (53-79)	61 (44-75)	0.379
Male (%)	2,694 (59)	7 (64)	28 (62)	0.839
Co-morbidities (%) (may be more than one)				
Hypertension	2,240 (49)	6 (55)	22 (49)	0.928
Coronary artery diseases	455 (10)	0 (0)	5 (11)	0.526
Congestive heart failure	106 (2)	0 (0)	1 (2)	0.878
Vascular disease	260 (6)	1 (9)	7 (16)	0.016
Stroke	269 (6)	2 (18)	5 (11)	0.075
Asthma	74 (2)	0 (0)	1 (2)	0.867
COPD	209 (5)	1 (9)	2 (4)	0.770
Diabetic mellitus	1,005 (22)	4 (36)	9 (20)	0.486
Chronic kidney disease	434 (9)	1 (9)	7 (16)	0.379
Primary diagnosis of surgical ICU admission (%)				0.007
Cardiovascular	723 (16)	2 (18)	14 (31)	
Respiratory	354 (8)	3 (27)	4 (9)	
Abdominal	1,858 (40)	0 (0)	11 (24)	
Head and neck	230 (5)	2 (18)	4 (9)	
Sepsis	167 (4)	1 (9)	4 (9)	
Trauma	322 (7)	0 (0)	5 (11)	
Renal	369 (8)	3 (27)	1 (2)	
Obstetrics-Gynecology	123 (3)	0 (0)	1 (2)	
Musculoskeletal and dermatology	309 (7)	0 (0)	1 (2)	
Others	141 (3)	0 (0)	0 (0)	
Smoking status (%)				0.631
None	2,909 (63)	7 (63)	31 (69)	
Current smoker	552 (12)	0 (0)	5 (11)	
Ex-smoker	1,135 (25)	4 (36)	9 (20)	
Surgical status at ICU admission (%)				
Post-operation				<0.001
Elective	2,488 (54)	8 (73)	5 (11)	
Emergency	1,131 (25)	1 (9)	16 (36)	
Non post-operation	977 (21)	2 (18)	24 (53)	
ASA classification (%) (data from 3,564 cases)				<0.001
Class I	234 (7)	0 (0)	1 (5)	
Class II	1,126 (32)	2 (25)	3 (14)	
Class III	1,737 (49)	5 (63)	6 (29)	
Class IV	386 (11)	1 (13)	11 (52)	
Class V + VI	52 (1)	0 (0)	0 (0)	
Surgical site (%) (data from 3,656 cases)				
Head and neck	321 (7)	1 (9)	3 (7)	0.960
Thoracic	186 (4)	1 (9)	1 (2)	0.575
Cesarean section	24 (0.5)	0 (0)	1 (2)	0.291
Upper abdomen	1,290 (28)	2 (18)	9 (20)	0.375
Lower abdomen	1,272 (28)	3 (27)	7 (16)	0.194
Spine	147 (3)	0 (0)	1 (2)	0.779
Peripheralvascular disease	143 (3)	0 (0)	2 (4)	0.735
Extremities	385 (8)	0 (0)	0 (0)	0.078
Severity of diseases (IQR)				
SOFA score	2 (1-5)	4 (2-6)	8 (5-11)	<0.001
APACHE II	10 (7-15)	11 (8-18)	19 (14-28)	<0.001

SD = standard deviation; IQR = interquartile range; ASA = the American Society of Anesthesiologists physical status; APACHE-II score = Acute Physiology and Chronic Health Evaluation-II score; SOFA score = Sequential Organ Failure Assessment score

fifth had refractory episode (nine cases). However, 14 cases had a previous diagnosis of seizure before ICU admission. Triggering of seizure was mostly due to intracranial lesion (21 cases). Diazepam was the most commonly prescribed medication for treating first episode seizure; other medications included phenytoin, valproic acid, phenobarbital, and propofol, which were commonly ordered for refractory cases. The success rate of stopping a first seizure episode was 36%. Patients were usually discharged from the ICU with complete recovery and given epileptic drugs to control seizure activity (Table 4).

The main outcomes of our study showed statistical significance between groups (Table 5). ICU mortality rate of stroke patients was at 18% (2 cases), seizure patients at 36% (16 cases), and non-stroke and non-seizure patients at 9% (429 cases), $p<0.001$. A 28-day hospital mortality rate of stroke patients was 18% (2 cases), seizure patients 42% (19 cases), and non-stroke and non-seizure 14% (621 cases), $p<0.001$. Duration of ICU stay was 6 (4-18) days for stroke patients, and 10 (4-16) days for seizure patients. Both

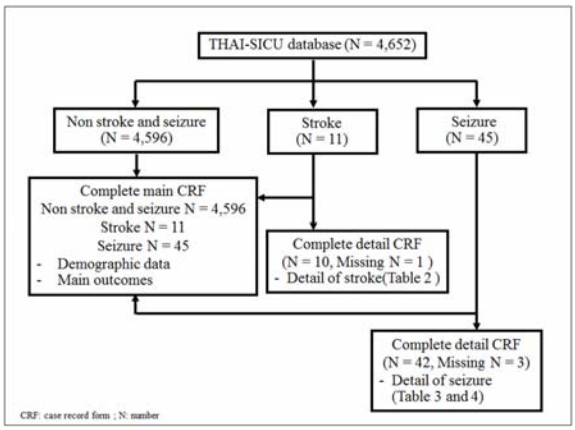

Fig. 1 Study flow and analysis.

Table 2. Information of stroke diagnosis in Thai-SICU study

Details for stroke admission	n = 10
First detected by	
Surgical and anesthetic residents	3
ICU attending physicians	1
ICU nurses	4
Family or patient relative	2
First personnel to diagnose	
Surgical and anesthetic residents	4
ICU attending physicians	6
First symptoms	
(may be more than one presentation)	
Drowsiness	2
Weakness	10
Seizure	2
Pre-existing stroke	2
Type of strokes	
Transient ischemic attack	2
Infarction	7
Hemorrhage	1
Treatment	
Supportive care	9
Surgery	1
Cerebral performance category (CPC)	
score at ICU discharge	
CPC 1	2
CPC 2	5
CPC 3	1
CPC 4	0
CPC 5	2

ICU = intensive care unit

Table 3. Information of seizure in Thai-SICU study

Details of seizure admission	n = 42
First detected by	
Surgical and anesthetic residents	6
ICU attending physicians	2
ICU nurses	34
Type of seizures	
Simple and complex partial seizure	12
Generalizednon-convulsive and convulsive seizure	24
Previous seizure before admission	14
Status epilepticus	23
Refractory status epilepticus	9
Cause of seizure*	
Intracranial lesions	24
Metabolic abnormality	15
Drugs suspected	9
Final neurologic ICU discharge	
Complete recovery without epileptic drug	7
Complete recoverywith epileptic drug	13
Partial recovery	1
Bed ridden	5
Dead	16

* Intracranial lesions included tumor, stoke, trauma, subarachnoid hemorrhage, and ischemic encephalopathy; metabolic abnormality included hepatic and uremic encephalopathy, and electrolyte imbalance; drug suspicious included Imipenem, Meropenem, and Metronidazole
ICU = intensive care unit

Table 4. Medications used for seizure and outcome of treatment

Anti-epileptic drugs prescription	First episode n = 37 (%)	Second episode n = 23 (%)	Third episode n = 9 (%)	Forth episode n = 7 (%)	Fifth episode n = 3 (%)
Diazepam	24 (67)	3 (13)	-	-	-
Midazolam	2 (6)	3 (13)	2 (22)	1 (14)	-
Clonazepam	1 (3)	-	1 (11)	-	-
Phenytoin	8 (22)	10 (44)	-	2 (29)	-
Fosphenytoin	-	2 (9)	-	1 (14)	-
Thiopental	-	-	2 (22)	-	-
Phenobarbital	-	2 (9)	-	2 (29)	-
Propofol	2 (6)	-	1 (11)	1 (14)	3 (100)
Valproic acid	-	3 (13)	3 (33)	-	-
Treatment outcomes					
Success	13 (36)	14 (60)	2 (22)	4 (57)	2 (67)
Transient success	19 (53)	7 (30)	3 (33)	2 (29)	1 (33)
Failure	4 (11)	2 (9)	4 (44)	1 (14)	-

Table 5. Outcomes of surgical intensive care patients with stroke and seizure from Thai-SICUs study

	None (n = 4,596)	Stroke (n = 11)	Seizure (n = 45)	*p*-value
Intensive care unit mortality (%)	429 (9)	2 (18)	16 (36)	<0.001
28-day hospital mortality (%)	621 (14)	2 (18)	19 (42)	<0.001
Length of intensive care unit stay (IQR)	2 (1-4)	6 (4-18)	10 (4-16)	<0.001
Length of hospital stay (IQR)	15 (9-26)	30.5 (19-41)	25 (12.5-47)	0.001

IQR = interquartile range

were longer than non-stroke and non-seizure patients (2 (1-4) days), $p<0.001$. There was also longer length of hospital stay in stroke and seizure patient (30.5 (19-41) days and 25 (12.5-47) days, respectively) than non-stroke and non-seizure patients (15 (9-26) days), $p = 0.001$ (Table 5).

Multivariable regression analysis was applied to the above outcomes adjusted by ASA, APACHE II, and SOFA score (as shown in Table 6). The researchers found no statistically significant difference in ICU mortality between stroke and seizure patients, after adjustment, and the non-stroke and non-seizure group (adjusted odds ratios were 3.89 (95% CI 0.44-34.42) and 0.83 (95% CI 0.21-3.19), respectively). This was the same as 28-day mortality of stroke and seizure compared with non-stroke and non-seizure group (1.69; 95% CI 0.20-14.51 and 0.78; 95% CI 0.23-2.64, respectively). Moreover, the authors tried to adjust length of ICU stay and hospital stay by the scores mentioned above (ASA, APACHE-II, and SOFA score) and found a significantly longer ICU length of stay in stroke and seizure over non-stroke and non-seizure patients (6.07 days; 95% CI 3.34-8.80 and 3.88 days; 95% CI 2.15-5.62, respectively), although, there was no significance in length of hospital stay after adjustment.

Discussion

Stroke and seizure are some of the most serious adverse events for post-operative patients[1-3]. At the present, there is no concentration on the effect of stroke and seizure patient in the surgical intensive care unit.This study tried to demonstrate these neurological complications in surgical patients from the multicenter Thai-SICUs study. The authors found 0.2% of patients suffered stroke and 1% suffered seizure from this ICU cohort. In addition, the ICU and 28-day ICU mortality were significantly different between patients with or without these neurological complications. However, this significance did not persist when adjusted by patient severity score (ASA, APACHE-II, and SOFA).

Table 6. Multivariable regression analysis of the outcomes after adjusted by patients' severity scores in stroke and seizure patient compared with non-stroke and non-seizure from Thai-SICUs study

Outcomes*	Value	(95% CI)	*p*-value
Intensive care unit mortality	Adjusted OR		
Non-stroke and seizure	Reference		
Stroke	3.89	0.44 to 34.42	0.222
Seizure	0.83	0.21 to 3.19	0.780
28-day hospital mortality	Adjusted OR		
Non-stroke and seizure	Reference		
Stroke	1.69	0.20 to 14.51	0.634
Seizure	0.78	0.23 to 2.64	0.685
Length of intensive care stay	Adjusted Coef		
Non-stroke and seizure	Reference		
Stroke	6.07	3.34 to 8.80	<0.001
Seizure	3.88	2.15 to 5.62	<0.001
Length of hospital stay	Adjusted Coef		
Non-stroke and seizure	Reference		
Stroke	7.05	-6.80 to 20.90	0.318
Seizure	8.61	-0.62 to 17.84	0.068

* All of the outcomes adjusted by the American Society of Anesthesiologists physical status, Acute Physiology and Chronic Health Evaluation-II score, and Sequential Organ Failure Assessment score
OR = odds ratio; Coef = Coefficient

Nevertheless, the researchers still found significance in longer ICU length of stay for stroke and seizure patients than those without these complications.

Ng JL et al[5] found an incidence of 0.05-7% of perioperative stroke after non-cardiac and non-neurological surgery. Most of these were thrombotic in origin. These occurrences might be underestimated due to patients with mild neurological deficit, transient attack, or even misdiagnosed as a consequence of sedative drugs or muscle relaxants which mask the assessment of a patient's neurological status[2]. Other potential causes of postoperative stroke include a withholding of anti-coagulant and anti-platelet during perioperative period, triggering of hypercoagulable cascade from surgical induced inflammation, or by disease itself, a refusal to use pre-operative beta blocker and statin, and perioperative hypotension[6].

According to a study by Mash our GA et al[7], independent predictors of stroke included age over 62 years old, history of myocardial infarction within 6 months before surgery, acute renal failure, history of stroke, dialysis, hypertension, history of transient ischemic attack, chronic obstructive pulmonary disease, current tobacco use; a protective factor was body mass index at 35-40 kg/m^2. In our cohort, the average age of stroke patients was 70 years old and only pre-existing vascular disease was identified as significant between different groups. Nevertheless, pre-existing history of stroke had a degree of difference (p = 0.075). Refer to Mash our study[7] demonstrated that stroke events were associated with an 8-fold increase in perioperative mortality within 30 days. However, we did not find any significance in ICU mortality and 28-day hospital mortality among stroke patients after adjusting patient severity scores.

Nurses were the first to detect signs and symptoms of stroke, especially weakness of extremities. Unfortunately, it might be late detection, so higher sensitivity screening tools are needed. For example, the Face Arm Speech Time (FAST)[8], Los Angeles Prehospital Stroke Screen (LAPSS)[9], Melbourne Ambulance Stroke Screen (MASS)[10], Recognition of Stroke in the Emergency Room (ROSIER)[11] and National Institutes of Health Stroke Scale (NIHSS)[12] which have been studied in many circumstances; however, these still need to be validated in critical care setting.

Causes of seizure in perioperative and post-operative patients in the surgical intensive care unit are multifactorial. Additional concerns for these patients are composed of a prolonged nil per oral status, surgical induced stress, hyperventilation and anesthetic drug interaction[13]. The incidence of epilepsy reported by Ziai WC et al[14] was 3% of patients

with status epilepticus, and this was associated with a higher mortality of up to 30%. Another study by Towne AR et al[15] showed intracranial lesions were the most common cause of seizure (most of them were hypoxic encephalopathy and preexisting stroke). From our study, only 1% of seizures were identified but these were associated with a huge amount of mortality (36%); over half of them had status episode and one-fifth developed refractory type. In addition, intracranial lesions were the most common cause of seizure. Regarding seizure treatment, benzodiazepines were mostly prescribed as first line agents, according to recommendations from international guidelines[16].

The limitations of this study were, first, a small number of stroke and seizure patients compared to non-stroke and non-seizure group, resulting in a limited variety of statistical analysis, particularly to demonstrate specific risk factors of seizure and stroke in surgical intensive care patients. Second, routine electroencephalography monitoring was limited in some centers, so non-convulsive status epilepticus might be underestimated, in particular those withdrawn from anti-epileptic agents or benzodiazepines might have been missed. However, this study might be the first large multicenter epidemiological study about stroke and seizure in surgical intensive care units in Thailand. The authors hope that this information will be incorporated in future care planning for intensive care patients.

Conclusion

From this present study, patients admitted to surgical intensive care units, who experienced new episodes of stroke and seizure, had longer ICU length of stay than non-stroke and non-seizure patients. Therefore, increased awareness and management of predisposing risk factors with early detection should result in improved patient outcomes.

What is already known on this topic?

The incidence of perioperative stroke and seizure after general non-cardiac surgery as reported from foreign countries is low; however, these affected patients were in discharge status. In addition, research on these conditions has not been studied in surgical intensive care units in Thailand before.

What this study adds?

This study presents Thai surgical intensive care unit data about the incidence and outcomes of patients with stroke and seizure by a large-scale epidemiological study. The results showed that while the incidence of these problems was not great, they nevertheless played a role in worse patient outcomes.

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Potential conflicts of interest

None.

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อุบัติการณ์, คุณลักษณะและผลลัพธ์ของผู้ป่วยที่มีโรคหลอดเลือดสมองและโรคลมชักขณะเข้ารับการรักษาในหออภิบาลผู้ป่วยภาวะวิกฤตทางศัลยกรรม (การศึกษา THAI-SICU)

ศิริพร ศิระเกล้า, กลวิชย์ ตรองตระกูล, กวีศักดิ์ จิตตวัฒนรัตน์, ชมพูนุท ปธนสมิทธิ์, ธนาวดี ธีรัชฌานันท์, สุจารีย์ ภู่พิพัฒน์ภาพ, กลุ่มศึกษา THAI-SICU

วัตถุประสงค์: *เพื่อศึกษาอุบัติการณ์, คุณลักษณะและผลลัพธ์ที่เกิดในผู้ป่วยที่มีโรคหลอดเลือดสมองและโรคลมชักขณะเข้ารับการรักษาในหออภิบาลผู้ป่วยภาวะวิกฤตทางศัลยกรรม*

วัสดุและวิธีการ: *การศึกษานี้เป็นการศึกษาเชิงวิเคราะห์แบบเก็บข้อมูลไปข้างหน้าในหออภิบาลผู้ป่วยภาวะวิกฤตทางศัลยกรรมของคณะแพทยศาสตร์ 9 แห่ง ในประเทศไทยซึ่งต้องการศึกษาเกี่ยวกับอุบัติการณ์และผลลัพธ์ในผู้ป่วยที่มีโรคหลอดเลือดสมองและโรคลมชักจากผู้ป่วยทั้งหมด 4,652 ราย ตั้งแต่เดือนเมษายน พ.ศ. 2554 ถึง เดือนมกราคม พ.ศ. 2556*

ผลการศึกษา: *จากการศึกษาพบว่าผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยภาวะวิกฤตมีอุบัติการณ์การเกิดโรคหลอดเลือดสมอง และโรคลมชัก ร้อยละ 0.2 และ 1 ตามลำดับ นอกจากนี้ยังพบว่าคุณลักษณะในกลุ่มผู้ป่วยที่มีโรคหลอดเลือดสมองและโรคลมชัก เมื่อเทียบกับกลุ่มที่ไม่มีภาวะดังกล่าวมีความแตกต่างอย่างมีนัยสำคัญทางสถิติดังนี้คือ สาเหตุการณ์เข้ารับการรักษาในหออภิบาลฯ, ค่าการประเมินความรุนแรงของโรคได้แก่ ASA classification, APACHE-II และ SOFA score ใน 24 ชั่วโมงแรกในส่วนของผลลัพธ์พบว่าเมื่อเทียบผู้ป่วยโรคหลอดเลือดสมอง, ผู้ป่วยโรคลมชัก, และผู้ป่วยที่ไม่มีภาวะดังกล่าวมีอัตราการเสียชีวิตและจำนวนวันนอนในหออภิบาลฯ มีความแตกต่างอย่างมีนัยสำคัญทางสถิติดังนี้คือ ร้อยละ 18 vs. 36 vs. 9, p<0.001 และ 6 (4-18) vs. 10 (4-16) vs. 2 (1-4) วัน, p<0.001 ตามลำดับ อย่างไรก็ตามเมื่อทำการวิเคราะห์การถดถอยพหุโลจิสติกส์ด้วยคะแนนความรุนแรงของโรค (ASA, APACHE-II, และ SOFA) แล้วพบว่าจำนวนวันนอนในหออภิบาลยังคงมีนัยสำคัญทางสถิติ โดยผู้ป่วยที่มีโรคหลอดเลือดสมองและผู้ป่วยโรคลมชักมีจำนวนวันในหออภิบาลนานกว่าผู้ป่วยไม่มีภาวะดังกล่าว 6.07 วัน (95% CI 3.34-8.80) และ 3.88 วัน (95% CI 2.15-5.62) ตามลำดับ*

สรุป: *จากผลการศึกษาผู้ป่วยที่เข้ารับการรักษาในหออภิบาลผู้ป่วยภาวะวิกฤตทางศัลยกรรมในประเทศไทย พบว่าจำนวนวันนอนในหออภิบาลศัลยกรรมของผู้ป่วยที่มีโรคหลอดเลือดสมองและโรคลมชักมีจำนวนวันสูงกว่ากลุ่มผู้ป่วยที่ไม่มีภาวะดังกล่าว หลังจากวิเคราะห์ด้วยการปรับความรุนแรงของโรคแล้ว*