The Thai Anesthesia Incident Monitoring Study (Thai AIMS) of Postoperative Central Neurological Complications

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Objective: *To analyze the incidents of central neurological complication in the Thai Anesthesia Incident Monitoring Study (Thai AIMS).*
Material and Method: *A prospective descriptive multi-centered study of incident reports was conducted in 51 hospitals across Thailand from January to June 2007. Voluntary and anonymous reports of any adverse events during the first 24 hrs of anesthesia were sent to the Thai AIMS data management unit. Three anesthesiologists reviewed the possible central neurological complication reports. Descriptive statistics was used.*
Results: *There were 16 relevant incident reports of central neurological complications (7 cases of convulsion, 5 cases of cerebro-vascular accident and 4 cases of coma). Majority of patients appeared to be old with underlying co-morbidities undergoing major surgical procedures under general anesthesia and required more intensive intra-operative monitoring. These complications occurred commonly with patients of orthopedics, cardiac, urologic and neurosurgical surgery. The majority of cerebro-vascular accident (80%) and coma (75%) were considered preventable.*
Conclusion: *Inappropriate decision making and inexperienced anesthesiologists were common contributing factors while suggested corrective strategies were quality assurance activity, clinical practice guidelines and improvement of supervision.*

Keywords: *Convulsion, Cerebro-vascular accident, Coma, Neurological, Complication, Incident reports*

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Although neurological complications are not common in the perioperative period, they are mainly associated with major, long-term disabilities and fatalities. Advances in emergency medical and surgical management in appropriate patients would result in improvement in patient safety[1]. The strategies to prevent perioperative neurological complications are definitely better than cure; therefore, the authors have to know the surgical patients who are at risk for the development of such complications so that the anaesthetic management would be tailored made for them with the appropriate intra-operative monitoring and maintenance of stability in hemodynamics[2,3].

In Thailand, the Royal College of Anesthesiologists of Thailand organized the Thai Anesthesia Incidents Study (THAI Study) of anesthesia which related adverse events from a registry of database of 20 hospitals across the country[2-5]. In 2007, the second nationwide study of anesthesia incident reports was initiated in 51 hospitals namely the Thai Anesthesia Incidents Monitoring Study (Thai AIMS)[6,7].

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The purpose of the present study was to identify the incidence of 24-hr perioperative central nervous system complications [coma, cerebrovascular accident or (CVA) and convulsion] among 1996 incident reports of the Thai AIMS. Other objectives were to examine the clinical cause, contributing factors and suggested corrective strategies.

Material and Method

This prospective multi-centered study, a part of the Thai Anesthesia Incident Monitoring Study (Thai AIMS), was conducted by the Royal College of Anesthesiologists of Thailand from January to the end of June 2007. All anesthesiologists and nurse anesthetists in fifty-one hospitals ranging from district (community) hospitals to tertiary hospitals across Thailand were invited to report the critical incidents on an anonymous and voluntary basis.

After being approved by each institutional ethical committee, the specific anesthesia related adverse events detected during anesthesia and during 24 hr postoperative period were reported by filling out a standardized incident reporting form as soon as possible after occurrence of adverse or undesirable events. These included pulmonary aspiration, pulmonary embolism, esophageal intubation, endobronchial intubation, oxygen desaturation, re-intubation, difficult intubation, failed intubation, total spinal block, awareness during general anesthesia, coma, cerebrovascular accidents (CVA), convulsion, nerve injuries, transfusion mismatch, suspected myocardial infarction/ischemia, cardiac arrest, death, suspected malignant hyperthermia, anaphylaxis, drug error, equipment malfunction and cardiac arrhythmia requiring treatment. The surgical profiles, anesthesia profiles and a narrative of incidents were also recorded. Details of the present study methodology have been described.

The incident reports of suspected central neurological complications including coma, cerebrovascular accidents (CVA) or convulsion were reviewed by 3 independent anesthesiologists. Patients with pre-anesthetic neurological disorder were excluded. Patients receiving cardiopulmonary resuscitation were also excluded because they were reported in the cardiac arrest group. Descriptive statistics was used for analysis.

Results

Among 1996 incident reports and 2537 incidents, there were 16 relevant data of central neurological complications (coma, CVA, convulsion) which were 0.8% of all patients or 0.6% of all incident reports. The authors excluded 8 incidents: prolonged emergence (2 cases), cardiac arrest (2 cases) pre-anesthetic comatose (3 cases) and a case of transient loss of consciousness during severe hypotension after spinal anesthesia. Among 16 cases, there were 10 male (62.5%) and 6 female patients (37.5%). Average age of the patients was 45.5 $\pm$ 25.4 years ranging from 14 to 92 years. Details of demographic characteristics and monitoring using for all 16 patients are shown in Table 1.

The perioperative neurological complications occurred more frequently in the post anesthetic period. Most of the incidents (15 cases or 93.75%) occurred in patients receiving general anesthesia. There was one intra-operative convulsion incident in a caesarean delivery patient under spinal anesthesia. Anesthetic, surgical characteristics and outcomes of patients are demonstrated in Table 2. Three cases of postoperative convulsion receiving neurological imaging scan whose results revealed normal finding (1 case), multiple small cerebral infarction (1 case) and subarachnoid hemorrhage (1 case). Among 5 cases of stroke who

Table 1. Demographic characteristics and monitoring of patients with central neurologic complications (n = 16)

Convulsion (n = 7)	
Ratio of male : female	5 (71.4%) : 2 (28.6%)
Age (yr): mean $\pm$ SD, (min-max)	42.7 $\pm$ 25.1 (29, 78)
Cerobro-vascular accident (CVA) (n = 5)	
Ratio of male : female	3 (60.0%) : 2 (40.0%)
Age (yr): mean $\pm$ SD, (min-max)	48.0 $\pm$ 30.6 (14, 92)
Coma (n = 4)	
Ratio of male : female	2 (50.0%) : 2 (50.0%)
Age (yr): mean $\pm$ SD, (min-max)	47.5 $\pm$ 26.0 (15, 77)
Monitoring (n = 16)	
NIBP	16 (100%)
SpO_2	16 (100%)
ECG	16 (100%)
End tidal CO_2	9 (56.2%)
Invasive BP	7 (43.7%)
CVP	6 (37.5%)
Oesophageal stethoscope	4 (25.0%)
Airway pressure	3 (18.7%)
Temperature	7 (43.7%)

Values shown as number (%), mean $\pm$ SD, (min-max)

Table 2. Patient surgical characteristics and outcome

Incident	Sex/Age	ASA	Surgical procedure	Duration (min)	Immediate complication	Long term outcome
Convulsion 1	M/26	2	Awake craniotomy	420	Convulsion	None
Convulsion 2	F/77	3	Gastroscopy	75	Convulsion, GCS 11	None
Convulsion 3	M/78	3	Transurethral resection of prostate	300	Convulsion	None
Convulsion 4	F/21	3E	Caesarean section	35	Convulsion	None
Convulsion 5	M/18	3	Craniotomy, tumour removal	390	Convulsion, prolonged ventilatory support (3 days)	None
Convulsion 6	M/38	2	Craniotomy, tumour removal	120	Convulsion, prolonged ventilatory support (4 days)	None
Convulsion 7	M/41	2	Cervical posterior fusion	235	Convulsion, prolonged ventilatory support (3 days)	None
CVA 1	M/25	1	Percutaneous Nephrolithotripsy	60	Rt CVA	Disability, weakness
CVA 2	M/59	2	Transthoracic esophagectomy	470	Lt hemiplegia	Disability, weakness
CVA 3	M/50	2	Thoracic spine instrumentation	300	Paraplegia	Disability, prolonged hospital stay
CVA 4	F/92	3	Hemiarthroplasty	104	CVA	Disability, weakness
CVA 5	F/14	2	Renal angioplasty	150	Stroke, Transient ischaemic attack	None
Coma 1	F/56	3	Pericardial window	130	Coma after cardiac arrest	Prolonged ventilatory support
Coma 2	F/42	3	Aortic and mitral valve replacement	520	Coma	Disability, vegetative stage
Coma 3	M/15	2	Bidirection Glenn Shunt	900	Coma	Death
Coma 4	M/77	3	Lt Hernioplasty	160	Severe hypotension, coma	Vegetative, death

GCS = glasgow coma score, M = male, F = female, ASA = American Society of Anesthesiologists

received 4 computerized tomographic scanning and an MRA, the results revealed ischemic stroke (2 cases), normal finding (1 case) bony fragment (1 case) and vasculitis (1 case). After reviewing all incidents, factors considered to be associated with, prevent ability and types of error are shown in Table 3. The contributing factors, factors minimizing the incidents and suggested corrective strategies are shown in Table 4.

Discussion

Although perioperative neurological complications are not common, they can result in significant long-term morbidity and mortality as shown in the present study. The overall incidence for postoperative neurological complications has been reported as 0.02% by previous studies including phase I of the THAI studies[2,3,5]. In the present prospective study the incidence of perioperative neurological complications (convulsions, CVA, and coma) involved 16 incidents from the overall 1996 incidents of Thai AIMS which was comparable to the THAI Study[5].

These neurological complications were significantly more common in orthopedics, cardiac, urological, and neurosurgical procedures than the total incidents reported in the preliminary results of the Thai AIMS[7]. It is possible that these specialties included more of the aging patient population than the overall database, which has the average age of 44.4 years, and they required longer duration of anaesthesia and more complicated surgical procedures. The more complexity of these specialties was also shown by the higher proportion of more invasive intra-operative monitoring;

Table 3. Associated factors, preventability, and types of error of perioperative nervous system complication

Incident	Patient factor	Surgical factor	Anaesthesia factor	Preventability	Types of error
Convulsion 1	Frontal lobe tumour	-	-	Preventable	Rule-based
Convulsion 2	Old CVA, aging	-	-	-	-
Convulsion 3	Aging	-	-	-	-
Convulsion 4	-	-	High block, bradycardia	-	-
Convulsion 5	Brain tumour	-	-	-	-
Convulsion 6	Recurrent meningioma, epilepsy	-	Delayed detection of acidosis	-	-
Convulsion 7	-	Subdural haematoma	-	-	-
CVA 1	-	-	Intraoperative hypotension	-	-
CVA 2	Heavy smoking LVH by ECG	High risk surgery	Hypotension	Preventable	Knowledge, Skill-based
CVA 3	-	Spinal cord compression by a bony fragment	-	Preventable	Skill-based
CVA 4	Extreme age	-	Combined GA+RA	Preventable	Knowledge-based
CVA 5	Malignant hypertension (200/100 mmHg)	-	-	Preventable	Rule-based
Coma 1	Airway secretion	-	-	Preventable	Knowledge-based
Coma 2	-	Duration, mean BP during CBP 40-70 mmHg, tear IVC	-	Preventable	Skill-based
Coma 3	Congenital heart disease	Complex procedure, long duration, 3 cycles of CPB	-	-	-
Coma 4	Aging, thrombocytopenia	-	Hypovolemia, inappropriate dose of anaesthetics	Preventable	Knowledge-based

invasive BP, CVP, temperature, than the patients who did not have perioperative neurological complications.

The most common incidents involving peri-operative convulsion were associated with scheduled neurosurgical procedures for brain tumor removal, while another patient had cervical spine fusion and another one patient who had intra-operative convulsion was scheduled for TUR-P. The remaining two high risk patients for the development of perioperative convulsions involved a pre-existing history of epilepsy and a pregnant woman with severe preeclampsia. The majority of convulsion incidents appeared to be more spontaneous in nature while it should have been preventable in the last 2 incidents. Therefore, anesthetic management for high risk patients for convulsions, as well as neurosurgical procedures, requires high vigilance for the development of such complications, because the incidence of generalized tonic clonic convulsions in the presented series may happen at any stage of the perioperative time varying from the intra-operative period, the emergence period in operating theatres or recovery area to the surgical intensive care unit or patient wards.

The anticonvulsant should be administered early especially in patients with potential risk for seizure and should receive their medical therapy for seizure control. In this group of patients, history taking about seizure is important. However, postoperative anticonvulsive management in patients experiencing convulsions with brain tumors results an inconclusive debate, despite frequent problems in these patients[8-10], some episodes occurring in patients before getting their diagnosis or as a presenting symptom[8-10]. The American Academy of Neurology does not recommend

Table 4. Contrituting, minimizing factors and suggested corrective strategies of central neurologic complications

Factors	Cases (n = 16)	(%)
Contributing factors		
Fatigue	2	12.5
Inappropriate decision making	6	37.5
Inexperienced	4	25.0
Surgical team	4	25.0
Inadequate preoperative preparation	1	6.2
Lack of knowledge	2	12.5
Factors that may be minimising the incident		
Prior experience	8	50.0
High awareness	12	75.0
Improved surgical supervision	3	18.7
Skilled assistant	4	25.0
Relief staff	1	6.2
Suggested corrective strategies		
Quality assurance (morbidity & mortality conference)	14	87.5
Improved supervision	4	25.0
Clinical practice guideline	4	25.0
Additional training	1	6.2
More equipment provided	1	6.2

the administration of perioperative anticonvulsant prophylaxis[11] because this drug group may induce the activities of cytochrome P-450 which will complicate the drug interactions especially during anesthesia. Despite this clinical practice guideline, some neurosurgeons still prescribe prophylactic anticonvulsive medication. The common reason for the development of perioperative seizure in patients receiving anticonvulsants is their sub therapeutic serum level, therefore the requirement of drug monitoring should be included in patient care plans or pre-operative evaluation[9,10]. The newer anticonvulsant, oxcarbazepine, may be an alternative for perioperative seizure prevention, because it is easier to administer. Oxcarbazepine does not require drug monitoring and does not interfere with the activity of cytochrome P-450 activity[12].

In the surgical patients who developed postoperative stroke/cerebro-vascular accident, all 5 incidents had an acute onset within the first twenty-four hours following the procedures and were varied across surgical disciplines. The only one incident with a requirement of emergency reoperation was the report of paraplegia in the recovery area after a thoracic spine instrumentation to remove a bony fragment. There were two incidents of stroke preceded by generalized tonic clonic convulsions, while the remaining two incidents had intra-operative hypotensive episodes in previously hypertensive patients. Postoperative neurological imaging may not be helpful to diagnose the pathology in a patient who develops stroke because it may be too early for the change of brain image at the time for diagnosis. Therefore, some reports suggest that the magnetic resonance imaging is a better alternative[13].

There were four incident reports of patients who developed coma in the early postoperative period in the present study. The main risk factors in this patient group were, particularly surgical in nature, especially three elective cardiac procedures and the surgical complications during the procedure. There was injury of inferior vena cava during pericardial window and another injury of the right atrium during valve replacement. These two incidents were complicated by massive blood loss and hypovolemic shock. While the complexities of the bilateral Glenn shunt lead to the longer duration of cardiopulmonary bypass and require 2-3 cycles of the bypass support. The one and only one incident solely related to anesthetics was an aging patient with history of hypertension who received increasing concentration of inhalation anesthetics, so that hypotension with narrow pulse pressure developed shortly after the start of the operation.

All four coma incidents were considered to be preventable in nature especially the patients who underwent cardiac procedures with surgical complications. The longer period of cardiopulmonary bypass may result in impaired cerebral oxygenation due to hemodilution, vasoconstriction, and the left shift of oxygen-hemoglobin dissociation curve with intentional hypothermia[14-16]. Cerebral microemboli, detected in patients who underwent cardiopulmonary bypass, have long been the primary cause of perioperative neurologic complications. This reason may explain why the authors suggest the corrective strategies in avoiding the incidents with quality assurance, improved supervision, and the additional training. A recent report has shown that Glenn shunt can be successfully performed without the utilization of a cardiopulmonary bypass support[17]. The protective effects of beta-adrenergic blocking agents for the development of perioperative neurological complications have been shown especially the high risk cardiac surgical patients[18,19].

The suggestive corrective strategies for prevention of perioperative neurological complications in the present study involve mainly the quality

assurance through the morbidity and mortality conference, clinical practice guidelines, and improved supervision, while either the more equipment needed or additional training was involved in only one incident. The overall strategies were totally different from previous THAI Study[2,3].

The incidents of delayed emergence were excluded from the perioperative neurological complications because the authors considered that these incidents were not involved in the pathology of the central nervous system and all these patients had full recovery within the first 24 hours after surgical procedures. While the emergency patients with high ASA physical status and low Glasgow Coma Scale preoperatively also were expected to have a significant poor surgical and neurological outcome, these patients had been comatose before the anesthesia conduct so that these incidents should not be counted as an anesthesia incident, therefore the authors excluded these patients from the coma incidents as well.

One of the limitations of the present study is inadequate details of pre-operative data for the patients who developed perioperative neurological complications such as pre-operative medications especially the antihypertensive agents and statins. The authors may have missed some important patient history such as metabolic syndrome. Another limitation is under reporting of perioperative neurological complications despite having a co-ordinator who was responsible for reviewing the incident report at each participating institution.

In conclusion, the present prospective study shows that perioperative neurological complications are not common but they are contributive to severe disabilities and fatal outcomes. The anesthetists should be alerted with a history of pre-existing epilepsy and other potential risks for neurological complication. Intra-operative hypotension should be promptly corrected in a hypertensive patient to avoid the perioperative ischemic stroke and coma. Inappropriate decision making and inexperienced anesthesiologists were common contributing factors while suggested corrective strategies were quality assurance activity, clinical practice guidelines and improvement of supervision.

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ภาวะแทรกซ้อนของระบบประสาทส่วนกลางภายหลังการผ่าตัดในโครงการศึกษาภาวะแทรกซ้อนทางวิสัญญีในประเทศไทยโดยการรายงานอุบัติการณ์

ปฏิภาณ ตุ่มทอง, ปิ่น ศรีประจิตติชัย, สมรัตน์ จารุลักษณานันท์, ธนารัตน์ สุรัตนสัญญา,วรวุธ ลาภพิเศษพันธุ์

วัตถุประสงค์*: เพื่อวิเคราะห์อุบัติการณ์ของภาวะแทรกซ้อนของระบบประสาทส่วนกลางในโครงการศึกษาภาวะแทรกซ้อนทางวิสัญญีในประเทศไทยโดยการรายงานอุบัติการณ์ (Thai AIMS)*

วิธีการศึกษา*: การศึกษาสหสถาบันเชิงพรรณนาชนิดไปข้างหน้าโดยการรวบรวมรายงานอุบัติการณ์ภาวะแทรกซ้อนทางวิสัญญีที่เกิดขึ้นภายใน 24 ชั่วโมงหลังการผ่าตัดในโรงพยาบาล 51 แห่ง ในประเทศไทยระหว่าง เดือนมกราคม จนถึงสิ้นเดือนมิถุนายน พ.ศ. 2550 ด้วยหลักการสมัครใจและนิรนามวิสัญญีแพทย์ 3 คนทบทวน และวิเคราะห์อุบัติการณ์ และใช้สถิติเชิงพรรณนา*

ผลการศึกษา*: มีรายงานอุบัติการณ์ที่เข้าเกณฑ์ 16 รายงานอุบัติการณ์ประกอบด้วย การชัก 7 ราย, ภาวะแทรกซ้อนของหลอดเลือดสมอง 5 ราย และภาวะไม่รู้สึกตัว 4 ราย ส่วนใหญ่ของผู้ป่วย มักเป็นผู้ป่วยสูงอายุมีโรคประจำตัวเข้ารับการผ่าตัดใหญ่ภายใต้การให้ยาระงับความรู้สึก แบบทั้งตัวและมีการเฝ้าระวังอย่างเข้มงวด ผู้ป่วยที่เกิดภาวะแทรกซ้อนเหล่านี้มักเป็นผู้ป่วยรับการผ่าตัดกระดูก ผ่าตัดหัวใจ ผ่าตัดระบบทางเดินปัสสาวะ และผ่าตัดระบบประสาท ร้อยละ 80 ของผู้ป่วยภาวะแทรกซ้อนของหลอดเลือดสมอง และร้อยละ 75 ของผู้ป่วย ที่มีภาวะไม่รู้สึกตัวถือเป็นอุบัติการณ์ที่อาจป้องกันได้*

สรุป*: สาเหตุนำสู่การเกิดภาวะแทรกซ้อนได้แก่ การตัดสินใจไม่เหมาะสม และการขาดประสบการณ์ในการให้ยาระงับความรู้สึก วิธีป้องกันที่แนะนำได้แก่ กิจกรรมพัฒนาคุณภาพ แนวทางเวชปฏิบัติ และการปรับปรุงระบบให้คำปรึกษา*