Study of Model of Anesthesia Related Adverse Event by Incident Report at King Chulalongkorn Memorial Hospital

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Objective: *As a site of the Thai Anesthesia Incidents Monitoring Study (Thai AIMS), the authors continued data collection of incident reports to find out the frequency, clinical course, contributing factors, factors minimizing adverse events, and investigation of model appropriate for possible corrective strategies in a Thai university hospital.*
Material and Method: *A standardized anesthesia incident report form that included close-end and open-end questions was provided to the attending anesthesia personnel of King Chulalongkorn Memorial Hospital between January 1 and December 31, 2007. They filled it on a voluntary and anonymous basis. Each incident report was reviewed by three reviewers. Any disagreement was discussed to achieve a consensus.*
Results: *One hundred sixty three incident reports were filled reporting 191 incidents. There were fewer male (44%) than female (56%) patients and they had an ASA physical status classification 1 (41%), 2 (43%), 3 (10%), 4 (4%) and 5 (2%). Surgical specialties that posed high risk of incidents were general, orthopedic, gynecological, otorhino-laryngological and urological surgery. Locations of incident were operating room (85%), ward (8%) and recovery room (2%). The common adverse incidents were oxygen desaturation (23%), arrhythmia needing treatment (14%), equipment malfunction (13%), drug error (9%), difficult intubation (6%), esophageal intubation (5%), cardiac arrest (5%), reintubation (4%), and endobronchial intubation (4%). Adverse events were detected by monitoring only (27%), by monitoring before clinical diagnosis (26%), by clinical diagnosis before monitoring (21%), and by clinical diagnosis only (26%). Incidents were considered to be from anesthesia related factor (73%), system factor (16%) and preventable (47%).*
Conclusion: *Common factors related to incident were inexperience, lack of vigilance, haste, inappropriate decision, not comply with guidelines, and lack of equipment maintenance. Suggested corrective strategies were quality assurance activity, additional training, clinical practice guidelines, equipment maintenance, and improvement of supervision.*

Keywords: *Incident, Adverse event, Patient safety, Complication, Anesthesia*

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Quality in medical care requires that healthcare providers define an acceptable standard of care and take steps to meet that level. Unfortunately, it is not easy in practice, especially in a specialty such as anesthesia. This is because this specialty does not deal directly with the diseases or cures but supports surgery. Thus, it does not provide primary therapeutic treatment. To overcome this problem, the specialty has chosen presence or absence of adverse outcomes as indicator of quality of anesthesia care.

Patient safety has received increased attention in recent years[1]. Incident monitoring is now widely accepted as a useful tool for quality improvement and maintenance of high safety standards in anesthetic services[2-5]. The incident reports can be used for investigation of latent and active errors and analysis for corrective and preventive strategies[3].

In 2003, the Royal College of Anesthesiologists of Thailand initiated The Thai Anesthesia Incidents Study (THAI Study) of anesthetic adverse outcomes, as a registry of all consecutive anesthetics in 20 hospitals, to study incidences of anesthesia

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related complications[6,7]. During an 18 months period, analyses of parts of the database of 200,000 anesthetics led to 28 sub-studies. Therefore, the THAI Study provided the baseline incidences of adverse outcomes and some contributory factors for quality improvement. However, it was limited to patients in teaching and general hospitals. Therefore, in collaboration with the Nation Research Council of Thailand and The Thai Joint Commission on Hospital Accreditation, the Royal College of Anesthesiologists of Thailand decided to use the method of incident reporting to identify and analyze anesthesia related incidents in 51 hospitals (including university hospitals, tertiary hospitals general or provincial hospitals, and district hospitals) across Thailand during a 6-months period in 2007[8,9]. As a site of this multi-center study, we decided to continue the collection of incident reports during a 12-month period to study the contributing and preventive factors in a Thai university hospital.

Material and Method

The prospective multi-center Thai Anesthesia Incident Monitoring Study (Thai AIMS) was conducted by the Royal College of Anesthesiologists of Thailand between January and 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. As part of the Thai AIMS, the data collection of voluntary incident reports was continued at King Chulalongkorn Memorial Hospital, a 1500-bed university hospital.

After being approved by institutional ethical committee, the specific anesthesia related adverse events detected during anesthesia and during a 24-hour postoperative period were reported by filling out a standardized incident reporting form[8] as soon as possible after the adverse or undesirable events occurred. 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/cerebro-vascular accident/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. Oxygen desaturation in the present study was defined as SpO2 below 90% for more than three minutes or once below 85% detected by pulse oximetry. The surgical profiles, anesthesia profiles, and a narrative of incidents were also recorded. Details of the Thai AIMS study methodology have been described[9]. All forms were sent to data management unit at Chulalongkorn University. Descriptive statistics (Frequency tables with number and percentage) were used to analyze data by using SPSS for Windows version 12. Each critical incident was reviewed by three anesthesiologists. Discrepancies among the three members were resolved by discussion.

Results

One hundred sixty three incident report forms (163 cases) with 191 incidents were sent to the data management unit and screened by two authors. Ages of patients varied from newborn to 86 years. Seventy-one were male (43.6%) and 92 were female patients (56.4%). Mean (Standard deviation), minimum, maximum of height, weight, and age of patients were 157.3 ($\pm$ 16.9) cm, 61 cm, 182 cm, 56.2 ($\pm$ 20.9) kg, 1 kg, 140 kg, and 44.3 ($\pm$ 22.9) years, < 1 year, 86 years, respectively. According to the American Society of Anesthesiologists (ASA) classification, 67 (41.1%), 70 (42.9%), 17 (10.4%), six (3.7%), and three (1.8%) patients were in class 1, 2, 3, 4 and 5, respectively.

Among the 163 surgical procedures, 19 cases (11.7%), 14 cases (8.6%), and 29 cases (17.8%) were operated during non-official time, emergency condition, and ambulatory (out-patient) setting respectively. General surgery, gynecological surgery, and orthopedic surgery were the three most common specialties that reported the incidents. Details of specialties or sites of operation are demonstrated in Table 1. The mean (standard deviation), minimum and maximum of duration of anesthesia were 126.8 (95.2 min), 20 min and 600 min. Phase of anesthesia during adverse events are also shown in Table 1. Choices of anesthesia for patients that experienced adverse events were 128 (78.5%) general anesthesia, 31 (19%) spinal anesthesia, 2 (1.2%) total intravenous anesthesia (TIVA), 1 (0.6%) conscious sedation, and 1 (0.6%) Bier block. Performers of anesthesia were anesthesiologists (29.4%), anesthesia residents (66.8%), non-anesthesia residents (6.1%), and medical students (7.4%). Detectors of adverse events were anesthesiologists (54.6%), nurse anesthetists (1.8%), anesthesia residents (43.6%), non-anesthesia residents (6.1%), and medical students (4%). Monitoring used in the incident reports is shown in Table 2.

Among 191 critical incidents, 49 incidents (25.7%), 52 incidents (27.2%), and 90 incidents (47.1%)

Table 1. Specialties or sites of surgery, phase and location of 163 incident reports

	n (%)
General	50 (30.7)
Orthopedic	29 (17.8)
Gynecological	28 (17.3)
Otorhino-laryngological	12 (7.4)
Urological	9 (5.5)
Plastic	8 (4.9)
Endoscopic	5 (3.1)
Neurosurgical	4 (2.5)
Obstetric	3 (1.8)
Ophthalmologic	3 (1.8)
Thoracic	3 (1.8)
Cardiac	2 (1.2)
Major vascular	2 (1.2)
Diagnosis	1 (0.6)
Radiotherapy	1 (0.6)
Others	6 (3.7)
Phase	
Preinduction	6 (3.7)
Induction	34 (20.9)
Maintenance	75 (46.0)
Emergence	5 (3.1)
Recovery	8 (4.9)
Post recovery (in 24 hr)	6 (3.7)
Location	
Induction room	1 (0.6)
Intensive care unit	3 (1.8)
Operating room	139 (85.2)
Recovery room	4 (2.5)
Ward	14 (8.5)
Imaging	1 (0.6)

Table 2. Monitoring used in 163 incident reports

	n (%)
NIBP	163 (100)
Pulse oximetry	161 (98.8)
EKG	156 (95.7)
Capnometry	107 (65.6)
Airway Pressure	88 (54.0)
Temperature	29 (17.8)
ET GAS	18 (11.0)
Invasive BP	14 (8.6)
Central venous pressure	14 (8.6)
Esophageal stethoscope	5 (3.1)
Peripheral nerve stimulator	5 (3.1)
Precordial stethoscope	4 (2.5)
Pulmonary artery pressure	4 (2.5)
Electroencephalography	1 (0.6)

were detected by clinical diagnosis only, monitoring only, and both clinical diagnosis and monitoring equipment, as shown in Fig. 1. Forty incidents (20.9%) were detected by clinical diagnosis before monitoring while 50 incidents (26.2%) were detected firstly by monitoring equipments. The most common monitoring that firstly detected the incidents were pulse oximetry (34.6%), electrocardiography (18.8%), capnometry (11.5%), and noninvasive blood pressure monitoring (4.7%). The critical incidents classified by perioperative period are shown in Table 3. The immediate and long-term outcomes after the incidents are demonstrated in Table 4.

Oxygen desaturation

The majority (41 out of 45 cases: 91.1%) of oxygen desaturation incidents reported to the data management unit were intra-operative incidents while two incidents (4.4%) occurred in the post-anesthesia care unit. Most of the incidents (38 cases: 84.4%) (Table 5) occurred in patients receiving general anesthesia, but seven incidents (15.5%) occurred in patients receiving spinal anesthesia. Seventeen (37.7%) incidents were firstly detected by pulse oximetry and 15 incidents (33.3%) were clinically detected before detection by pulse oximeter. After peer review, the factors contributed to the occurrence of incidents are demonstrated in Table 6.

Cardiac arrhythmia needing treatment

Among 28 cardiac arrhythmia, 24 incidents (85.7%) were solely bradycardia (heart rate < 60 beat per min). Fifteen incidents (53.5%) and 13 incidents (46.4%) of cardiac arrhythmia occurred in patients receiving general anesthesia and spinal anesthesia, respectively. Ten cases out of 13 bradyarrhythmia (76.9%) after spinal anesthesia were considered due to high blockage. Anesthetic factors, particularly combination of pharmacologic effects after administration of medication, were considered major causes of bradycardia in patients receiving general anesthesia. Three incidents of premature ventricular tachycardia (PVC) and one incident of atrial fibrillation and supraventricular tachycardia occurred in the recovery room. Among patients factors considered to be contributing factors of the incidents, three cases (10.7% of all arrhythmia), four cases (14.2%), and four cases (14.2%) occurred in patients receiving beta-blocker, patients with preoperative history of bradyarrhythmia, and patients with preoperative cardiovascular diseases.

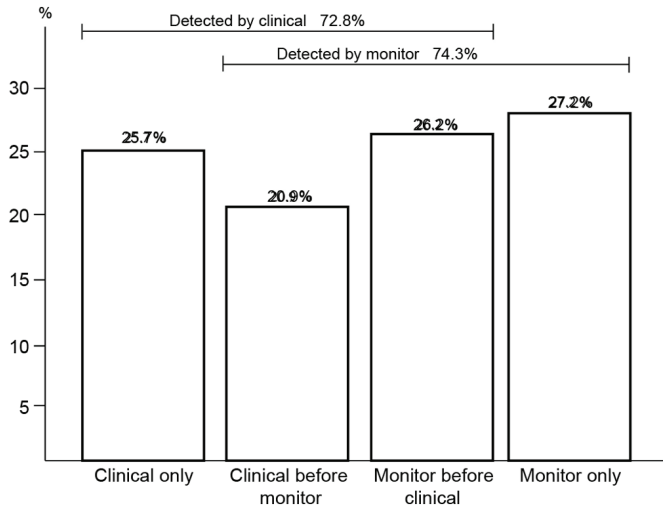

Fig. 1 Detection of incidents by clinical diagnosis and monitoring (n = 191 incidents)

Table 3. Incidents classified by perioperative periods (n = 191)

Incidents	Operative period n (%)	PACU n (%)	Post-op 24 hr n (%)	Total n (%)
Desaturation	41 (21.5)	2 (1.0)	2 (1.0)	45 (23.6)
Arrhythmia needed treatment	27 (14.1)	1 (0.5)	-	28 (14.6)
Equipment malfunction	25 (13.1)	-	-	25 (13.1)
Drug error	19 (9.9)	-	-	19 (9.9)
Difficult intubation	12 (6.3)	-	-	12 (6.3)
Esophageal intubation	11 (5.8)	-	-	11 (5.8)
Cardiac arrest	6 (3.1)	-	4 (2.1)	10 (5.2)
Endobronchial intubation	8 (4.1)	-	-	8 (4.1)
Reintubation	6 (3.1)	-	2 (1.0)	8 (4.2)
Anaphylaxis/anaphylactoid reaction	7 (3.7)	-	1 (0.5)	8 (4.2)
Pulmonary aspiration	3 (1.6)	1 (0.5)	-	4 (2.1)
Failed intubation	4 (2.1)	-	-	4 (2.1)
Suspected MI/ischemia	2 (1.0)	-	1 (0.5)	3 (1.5)
Pulmonary embolism	-	-	2 (1.0)	2 (1.0)
Awareness during GA	-	-	2 (1.0)	2 (1.0)
Coma/CVA/convulsion	-	-	1 (0.5)	1 (0.5)
Nerve injuries	-	-	1 (0.5)	1 (0.5)
	171 (89.5)	4 (2.1)	16 (8.4)	

Equipment malfunction

Among 25 equipment malfunction incidents, types of equipments related to incidents were anesthetic circuit (5 incidents; 20%), pulse oximetry (5 incidents; 20%), capnometer (3 incidents; 12%), operating theater monitoring: NIBP + EKG + pulse oximetry (3 incidents; 12%), vaporizer (3 incidents; 12%), anesthetic machine (2 incidents; 8%), expiratory unidirectional value (2 incidents; 8%), endotracheal tube (1 incident; 4%), anesthetic mask (1 incident; 4%), and mechanical ventilator (1 incident; 4%). Twenty-three incidents (92%), 14 incidents (56%), and 19 incidents (76%) were considered to be preventable, anesthesia-related, and system error respectively. There were six incidents (24%) of human error, three incidents (12%) of knowledge-based, one incident (4%) of rule-based, and two incidents (8%) of skill-based errors considered to be contributing factors.

Drug error

All 19 incidents (100%) of medication errors were considered as anesthesia-related. Five incidents (26.3%) occurred during induction and intubation period. The common agents related to drug error incidents were neuromuscular blocking agent (7 incidents; 36.8%), antibiotics (4 incidents; 21.1%), intravenous induction agents (2 incidents; 10.5%) and opioids (2 incidents; 10.5%). Among these, three errors (15.7%) were detected before drug administration and were diagnosed as near-miss incidents. Seven incidents (36.8%) were of error of type of drug, five (26.3%) were of error of drug concentration, five (26.3%) were of dosing error, one (5.3%) was of drug contamination, and one (5.3%) was of error of administration technique.

Table 4. Immediate outcomes and long term outcomes after the incidents (n = 191)

Outcomes	n (%)
Immediate outcomes (within 24 hr)	
Unplanned ICU admission	6 (3.1)
Unplanned hospital admission	1 (0.5)
Prolonged emergence/apnea	3 (1.6)
Cancellation/postponement of surgery	6 (3.1)
Minor physiological change	21 (11.0)
Major physiological change	53 (27.7)
Respiratory outcomes (hypoxia, pulmonary edema)	48 (25.1)
Cardiovascular outcomes (myocardial infarction)	4 (2.1)
Neurological outcomes	1 (0.5)
Death	8 (4.9)
Complete recovery	30 (15.7)
Longterm outcomes (within 7 days)	
Prolonged ventilatory support	5 (2.6)
Prolonged hospital stay	6 (3.1)
≤ 7 days	2 (1.0)
> 7 days	4 (2.1)
Death	9 (4.7)

Difficult intubation

Among 12 incidents of difficult intubation (Intubation ≥ 3 times or duration of intubation > 10 min), eight (66.6%) occurred in male patient. The incidents occurred in any age groups between 6 years and 75 years old. Four incidents (33.3%) occurred without preoperative suspection of difficult intubation, and nine cases (75%) were considered by reviewers to be patient factor related to difficult intubation. The successful intubation method after diagnosis of intubation were experienced intubator (8 cases; 66.6%), change to smaller endotracheal tube (5 cases; 41.6%), change to blind nasal intubation method (2 cases; 16.6%), usage of laryngeal mask airway (1 case; 8.3%), change of laryngoscope blade (1 case), and fiberoptic bronchoscopic assistance (1 case; 8.3%). Capnometry was considered helpful for confirmation of intubation in two cases (16.6%). After failure of intubation, the surgery was postponed in four cases (33.3%).

Reintubation

All eight incidents of reintubation occurred in children age ≤ 2 years or patients age > 60 years. Six incidents (75%) were considered to be anesthesia-related in which two (25%) were considered to be due to anesthetic overdose. Two incidents (25%) were considered as surgical factor related to endoscopy procedure. There were two reintubations in the postoperative period. A case of postoperative airway

Table 5. Factors related to adverse events and preventability

Adverse events (n total)	Patient factor n (%)	Surgical factor n (%)	Anesthetic factor n (%)	Human error n (%)	System error n (%)	Preventability n (%)
Desaturation (n = 45)	24 (53.3)	9 (20)	38 (84.4)	16 (35.5)	0 (0)	27 (60)
Arrhythmia needing treatment (n = 28)	12 (42.8)	5 (17.8)	24 (85.7)	3 (10.7)	1 (3.5)	4 (14.2)
Equipment malfunction (n = 25)	1 (4)	2 (8)	14 (56)	6 (24)	19 (76)	23 (92)
Drug error (n = 19)	0 (0)	0 (0)	16 (84.2)	19 (100)	3 (15.7)	19 (100)
Cardiac arrest (n = 10)	10 (100)	4 (40)	3 (30)	2 (20)	1 (10)	2 (20)
Difficult intubation (n = 12)	8 (66.6)	0 (0)	4 (33.3)	3 (25)	0 (0)	3 (25)
Esophageal intubation (n = 11)	4 (36.3)	0 (0)	9 (81.8)	8 (72.7)	1 (9.1)	9 (81.8)
Endobronchial intubation (n = 8)	2 (25)	2 (25)	8 (100)	6 (75)	0 (0)	6 (75)
Reintubation (n = 8)	4 (50)	2 (25)	7 (87.5)	4 (50)	0 (0)	6 (75)

Table 6. Contributing factors, factors minimizing incident and suggested corrective strategies n = 191

	n (%)
Contributing factors	
Inexperience	78 (40.8)
Haste	15 (7.9)
Inappropriate decision making	12 (6.3)
Emergency condition	9 (4.7)
Inadequate preoperative evaluation	9 (4.7)
Inadequate preparation	9 (4.7)
Ineffective equipment	9 (4.7)
Inadequate knowledge	8 (4.2)
Ineffective monitor	4 (2.1)
Unfamiliar to environment	3 (1.6)
Ineffective equipment	3 (1.6)
Communication defect	2 (1.0)
Problems regarding blood availability	2 (1.0)
Tiredness	1 (0.5)
Error in drug label	1 (0.5)
Factors minimizing incident	
Having experience	116 (60.7)
Vigilance	85 (44.5)
Comply to guidelines	15 (7.9)
Equipment maintenance	11 (5.8)
Experienced assistant	10 (5.2)
Adequate equipment	8 (4.2)
Equipment check up	7 (3.7)
Adequate monitoring equipment	6 (3.1)
Effective communication	4 (2.1)
Training	2 (1.0)
Adequate personnel	1 (0.5)
Suggested corrective strategies	
Quality assurance activity	164 (85.9)
Additional training	44 (23.0)
Clinical practice guidelines	26 (13.6)
Equipment maintenance	19 (9.9)
Improvement of supervision	13 (6.8)
More equipment	10 (5.2)
Improvement of communication	7 (3.7)
Good referral system	4 (2.1)
More manpower	2 (1.0)

obstruction due to hematoma after internal jugular venous catheterization and a case of late respiratory depression due to epidural morphine in patients receiving combined general and epidural anesthesia.

Esophageal intubation

Esophageal intubation was detected after intubation procedure in 11 patients. Four incidents (36.4%) were considered related to anatomical factors contributing to difficult intubation. Nine incidents (81.8%) were considered to be preventable and two (18.2%) could be prevented by preparation of capnometry (rule-based mistakes). Availability of equipment (capnometry) was another cause (9.1%) of preventable esophageal intubation. Ten incidents (90.9%) were firstly detected by clinical diagnosis before monitoring equipment whereas one incident (9.1%) was detected because of oxygen desaturation. Ten patients (90.9%) had no harm but one patients (9.1%) experienced pulmonary aspiration. All incidents were performed by residents (8 incidents) and medical students (3 incidents).

Endobronchial intubation

Among eight incidents of endobronchial intubation, two were considered patient factors (1 case of morbid obese and 1 case of infant) and another two were related to surgery (1 case of tracheal anastomosis and 1 case of intraoperative nasogastric tube manipulation). Four incidents (50%) of endobronchial intubation were detected firstly by clinical diagnosis and other four incidents were detected by monitoring.

Cardiac arrest

All 10 incidents of cardiac arrest occurred in patients receiving general anesthesia with mortality rate of 80%. Two incidents (20%) occurred in infant. Six patients (60%) experienced cardiac arrest during anesthesia whereas four patients (40%) experienced postoperative cardiac arrest. Seven fatal cases (70%) were male, five cases (50%) were operated in emergency condition, and four cases (40%) were associated with massive bleeding. One postoperative fatal case (10%) was considered to be due to suspected pulmonary embolism and three cases were related to airway or pulmonary problem. After peer review, four (40%), three (30%) and one incident (10%) were considered to be surgery-related, anesthesia-related, and system error, respectively.

Anaphylaxis or anaphylactoid reaction

Six cases out of seven (85.7%) anaphylaxis or anaphylactoid reaction were intraoperative incidents. Four incidents (57.1%) comprised of skin manifestation only such as skin rash or wheal, whereas three were cutaneaus manifestation together with hypotension. There was no incident with respiratory event in this case series. Six out of seven incidents (85.7%) occurred with complete recovery outcome. The other case developed ST depression necessitating prolonged hospital stay.

Pulmonary aspiration

Among nine incidents of pulmonary aspiration, three incidents (75%) occurred during induction period and one incident (25%) occurred in the post-anesthesia care unit. Two cases (50%) had pre-anesthetic full stomach. All but one developed hypoxia with complete recovery within 24 hr. Three incidents (75%) were considered as anesthesia-related adverse events.

Suspected pulmonary embolism

A 71-year-old male patients receiving hermiarthroplasty of left hip under general anesthesia developed sudden oxygen desaturation and severe hypotension during 24-hr postoperative period. This case was diagnosed as pulmonary embolism by lung scan, necessitating prolonged ventilatory support, and hospital admission. Another patient was a 59-year-old woman diagnosed as ovarian carcinoma scheduled for debulging tumor developed postoperative convulsion and sudden cardiovascular collapse. This was considered as suspected pulmonary embolism with failure cardiopulmonary resuscitation. Post-mortem autopsy was not allowed by relatives.

Awareness

There were two cases of awareness during anesthesia. The first incident occurred during intubation by a medical student under supervision of the instructor. The second incident occurred during maintenance phase due to vaporizer malfunction. Both incidents were considered preventable.

Nerve injury

An incident of bilateral brachial plexus injury occurred in a case of sex reassignment. This was considered as a surgical factor due to prolonged operative duration (6 hours) combined with anesthetic factor due to surgical positioning. The neurodeficit disappeared within four days after operation and this was considered preventable.

Prolonged emergence

A 3-month infant undergoing right ventriculo-peritoneal shunt had delayed emergence because of hypothermia. This patient was monitored with thermister and was considered as preventable incident.

After review of all 191 incident-reports by three anesthesiologists, 85 incidents (44.5%), 31 incidents (16.2%), 141 incidents (73.8%), and 32 incidents (16.8%) were considered patients factors, surgical factors, anesthetic factors, and system factors, respectively. The critical incidents were considered to be preventable, human error, rule-based mistakes, knowledge-based mistakes, and skill-based mistakes in 90 incidents (47.1%), 67 incidents (41.1%), 16 incidents (8.4%), 35 incidents (18.3%), and 16 incidents (8.4%), respectively. The contributing factors, factors minimizing the occurrence of adverse events, and suggestive corrective strategies are shown in Table 6.

Discussion

The present study revealed 191 incidents from 163 incident reports because some patients experienced more than one incident. The incidents reported to data management unit might be under-estimated. However, incident reporting posed greater likelihood of frank reporting of details because of guaranteed anonymity and gave more information including near-miss event[10]. Our results provided prospective data collection and allowed retrospective analysis of risk factors during 12-month period in a Thai university hospital. For demographic characteristics, patients who experienced incidents in the present study were older than the average age of the Thai population and those of patients in the THAI Study[6,7], but age distribution of patients in our study were similar to the nationwide incident reports in the Thai AIMS[9]. The weight and height of patients in this study were not different to those of the Thai AIMS[9]. Compared with gender ratio of female and male of 52.9%: 47.1% in THAI Study that represented patients undergoing surgery in Thailand, the gender ratio in our study were not different (female: male of 56.4%: 43.6%). The ASA physical status classification of patients was not different to that of the THAI Study[6,7]. However, the patients in our study comprised of patients with higher proportion of ASA physical status 1 and 2 than those of the Thai AIMS[9]. This is because our study reported a high frequency of airway or respiratory adverse events that occurred in healthy patients.

Among all 163 operations that reported the incidents, most incidents occurred in official time, elective condition, and in-patient setting, which was similar to several studies[6,9,11]. The three most common surgical specialties of patients who experienced incidents were general surgery, orthopedic surgery, and gynecological surgery. Critical incidents occurred most frequently in the operating room (85.2%) particularly during induction and maintenance phase. Other places where critical incidents occurred were ward and recovery room. Adverse events occurred in patients

receiving general anesthesia in almost four-fifths of anesthesia services. Although anesthesia residents were two-thirds of the performers of anesthesia service the most common detector of critical incidents were anesthesiologists or supervisor. It is interesting that medical students were the detectors of critical incidents (4%).

Non-invasive blood pressure monitoring, pulse oximetry, and electrocardiography were used as intraoperative monitoring during almost all surgical procedures, while capnometry was used in 65.6% of incidents. Among 191 incidents occurred, the most common monitoring equipment that firstly detected the critical incidents were pulse oximetry (34.6%), electrocardiography (18.8%), capnometry (11.5%), and non-invasive blood pressure monitoring (4.7%). In the Australia Incident Monitoring Study, the monitor firstly detected were pulse oximetry (27%), capnography (24%), electrocardiography (19%), and blood pressure monitor (12%)[12]. The possible explanation is capnometry was not routinely used in our institution. The model explaining detection of critical incidents in our study (Fig. 1) revealed that 27.2% of incidents could not be detected by clinical diagnosis and 25.7% of incidents could not be detected by monitoring equipment.

Oxygen desaturation, cardiac arrhythmia needing treatment, equipment malfunction, and drug error were common critical incidents reported. Among 45 cases of oxygen desaturation, 60%, 84.4%, 35.5%, and 20% were considered preventable, anesthetic factor, human error, and patient factor, respectively. Common anesthetic factors contributing to desaturation were relative overdosage and sedation. In the THAI Study, factors related to occurrence of intraoperative oxygen desaturation were age less than 5 years old, ASA physical status 3, 4, 5, general anesthesia, and long duration of anesthesia[13]. Our previous study of intraoeprative oxygen desaturation in geriatric patients revealed that the higher ASA physical status, history of difficult intubation, and recent respiratory failure were significant risk factors[14].

Bradyarrhythmia posed the majority (85.7%) of arrhythmia needing treatment in our institution. Bradycardia in patients receiving spinal anesthesia was considered to be due to relatively high spinal blockage while bradycardia in patients receiving general anesthesia were related to pre-anesthetic history of bradyarrhythmia, receiving beta-blocker, and preoperative history of cardiovascular disease. Among 25 equipment malfunction incidents, anesthetic circuit, pulse oximetry, capnometry and operating theater monitoring (NIBP + EKG + pulse oximetry), and vaporizer were common equipments related to the critical incidents. Three-fourths of the equipment malfunction incidents were system error, while 56% of incidents were considered to anesthetic factors. There was no major harmful event in the present study. The Australian Incidents Monitoring Study reported the 60% (107 out of 177 incidents) involved anesthetic equipment and 24% involved monitors[15]. In the THAI Study, Klanarong S et al reported that 63% and 16% of equipment malfunction involved anesthesia machine and laryngoscope respectively[16]. In our previous study, the incidence rates of intraoperative and 24-hr perioperative cardiac arrest were 11:10000 and 20.8:10000 anesthetics in our institution[17]. In this study, all of 24-hr perioperative cardiac arrest occurred in patients receiving anesthesia with mortality rate of 80%. Sixty percent of cardiac arrest occurred during intraoperative period. The common related factors were male gender, emergency condition, and massive bleeding, which confirmed our previous registry[17]. Forty percent of cardiac arrest incidents were considered surgical related while 30% were considered anesthesia related. All of these incidents occurred in patients with underlying disease whereas 20% were considered preventable.

Among incidents related to intubation, the most common incidents occurred were difficult intubation and esophageal intubation. The possible explanation was our institution is a residency training center. Two-thirds of difficult intubation incidents were considered patient factors. While one-third of patients had no pre-anesthetic suspicion of difficult intubation. Capnometry was considered helpful for confirmation of intubation in 16% of incidents. The range of preventability of incident related to endotracheal tube was 25% to 81%. The only incident (9%) of system factors were esophageal intubation in a condition of inadequate capnometry.

The practice of clinical anesthesia involves multiple intravenous administration of potent drugs, sometimes under condition of haste or stress. Medication errors occurred quite commonly. In our study, common agents related to drug errors were neuromuscular blocking agents, antibiotics, intravenous induction agents, and opioids, which confirmed the results of the THAI Study[18]. A quarter of drug error incidents occurred during the induction and intubation phase. Common errors were wrong drug (36%), wrong concentration (26%), and wrong dosage (26%). Most of the incidents were preventable. The possible

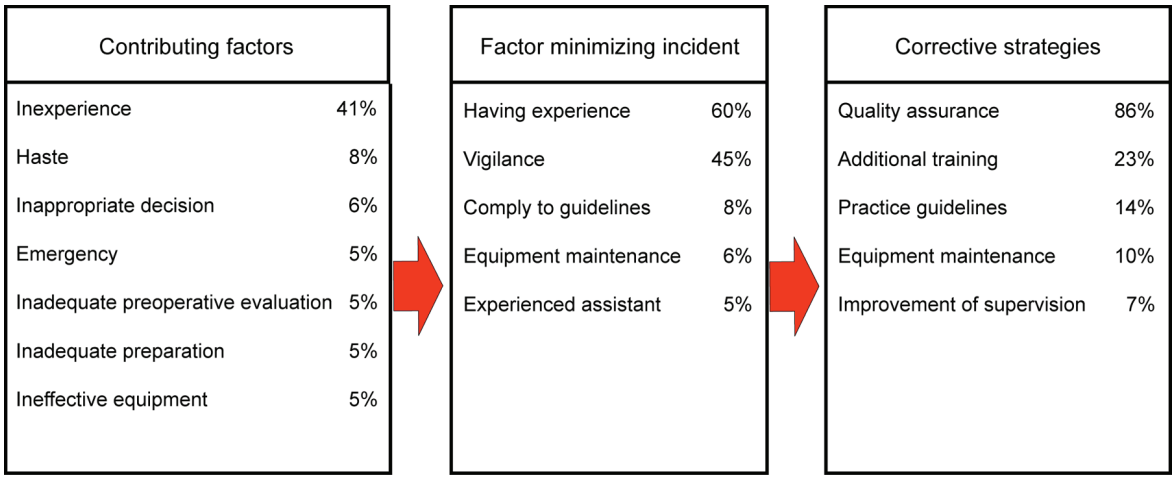

Fig. 2 Model of anesthesia related adverse events

preventive strategies might be drug labeling or color coding high alert drug and use of checking guidelines. Although incidents of awareness during general anesthesia and late detected esophageal intubation were considered preventable, some incidents such as suspected pulmonary embolism and anaphylaxis or drug allergy were mostly inevitable or spontaneously occurred. Model of anesthesia related adverse event in our institution was demonstrated in Fig. 2.

Conclusion

This series of incident reports representing a Thai university hospital showed that 73.8% and 16.8% were considered by the reviewer committee to be anesthesia related factor and system factor. Furthermore, 41.1% and 47.1% were considered to be human error and preventable. Factors that influenced the occurrence of incidents were inexperience, lack of vigilance, haste, inappropriate decision, not comply with guidelines, and lack of equipment maintenance. Suggested corrective strategies were quality assurance activity, additional training, practice guidelines, equipment maintenance, and improvement of supervision.

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Potential conflict of interest

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การศึกษาแบบจำลองการเกิดภาวะแทรกซ้อนทางวิสัญญีโดยการรายงานอุบัติการณ์ในโรงพยาบาลจุฬาลงกรณ์

อรุณชัย นรเศรษฐกมล, สมรัตน์ จารุลักษณานันท์, อรนุช เกี่ยวข้อง, พรเทพ เปรมสำราญ, ศราวุธ กันเดช

วัตถุประสงค์: *จากการเป็นส่วนหนึ่งของโครงการศึกษาภาวะแทรกซ้อนทางวิสัญญี ในประเทศไทยโดยการรายงานอุบัติการณ์ (Thai AIMS) ผู้นิพนธ์ทำการเก็บรายงานอุบัติการณ์ต่อเพื่อศึกษาปัจจัยนำปัจจัยลดอุบัติการณ์ เพื่อศึกษาแบบจำลองในการหาแนวทางแก้ไขปัญหาภาวะแทรกซ้อนในโรงพยาบาลมหาวิทยาลัยในประเทศไทย*

วัสดุและวิธีการ: *ผู้ให้ยาระงับความรู้สึก กรอกแบบฟอร์มรายงานอุบัติการณ์ ซึ่งเป็นแบบสอบถามปลายเปิดและปลายปิดเมื่อเกิดอุบัติการณ์ภาวะแทรกซ้อนทางวิสัญญี ในโรงพยาบาลจุฬาลงกรณ์ระหว่าง 1 มกราคม พ.ศ. 2550 ถึง 31 ธันวาคม พ.ศ. 2550 วิสัญญีแพทย์ 3 คน ทำการทบทวนอุบัติการณ์ และลงความเห็นหลังการอภิปรายเมื่อเกิดความเห็นแย้ง*

ผลการศึกษา: *พบรายงานอุบัติการณ์ 191 เหตุการณ์ ในผู้ป่วย 163 คน ในผู้ป่วยชาย 44% และหญิง 56% แบ่งสภาพกายภาพตามค่านิยามของสมาคมวิสัญญีแพทย์แห่งสหรัฐอเมริกา 1, 2, 3, 4 และ 5 เท่ากับ 41%, 43%, 10%, 4% และ 2% ตามลำดับ อุบัติการณ์เกิดบ่อยในผู้ป่วยศัลยกรรมทั่วไป ศัลยกรรมกระดูก นรีเวช หูคอจมูก และศัลยกรรมระบบทางเดินปัสสาวะ สถานที่เกิดอุบัติการณ์ได้แก่ ห้องผ่าตัด (85%) หอผู้ป่วย (8%) และห้องพักฟื้น (2%) อุบัติการณ์ที่เกิดขึ้นได้แก่ ภาวะระดับความอิ่มตัวของออกซิเจนต่ำ (23%) ภาวะหัวใจเต้นผิดปกติซึ่งต้องการการรักษา (14%) ความผิดปกติของเครื่องมือ (13%) ความผิดพลาดเกี่ยวกับยา (9%) ภาวะใส่ท่อหายใจยาก (6%) การใส่ท่อหายใจเข้าหลอดอาหาร (5%) ภาวะหัวใจหยุดเต้น (5%) การใส่ท่อหายใจใหม่ (4%) การใส่ท่อหายใจลึกเข้าหลอดลมปอด (4%) พบว่าการวินิจฉัยอุบัติการณ์ได้โดยเครื่องเฝ้าระวังอย่างเดียว (27%) เครื่องเฝ้าระวังก่อนการวินิจฉัยทางคลินิก (26%) การวินิจฉัยทางคลินิกก่อนเครื่องเฝ้าระวัง (21%) และวินิจฉัยทางคลินิกเพียงอย่างเดียว (26%) สาเหตุของการเกิดอุบัติการณ์ได้แก่ ปัจจัยทางวิสัญญี (73%) ปัจจัยเชิงระบบ (16%) และสามารถป้องกันได้ (47%)*

สรุป: *ปัจจัยเกี่ยวข้องกับการเกิดอุบัติการณ์ได้แก่ การขาดประสบการณ์ ขาดความรอบคอบระแวดระวัง ความรีบร้อน การตัดสินใจไม่เหมาะสม การไม่ปฏิบัติตามแนวทางเวชปฏิบัติ ขาดการบำรุงรักษาเครื่องมือ แนวทางแนะนำ ได้แก่ กิจกรรมประกันคุณภาพ การฝึกอบรมเพิ่มเติม การจัดทำแนวทางปฏิบัต การบำรุงรักษาเครื่องมือ และการปรับปรุงการให้คำปรึกษา*