The Thai Anesthesia Incidents Study (THAI Study) of Anesthetic Outcomes : II Anesthetic Profiles and Adverse Events

Somrat Charuluxananan MD*, Yodying Punjasawadwong, MD**,
Suwannee Suraseranivongse MD***, Surirat Srisawasdi MD****,
Oranuch Kyokong MD*, Thitima Chinachoti MD***,
Thavat Chanchayanon MD*****, Mali Rungreungvanich MD****,
Somboon Thienthong MD******, Chomchaba Sirinan MD****,
Oraluxna Rodanant MD*

** Department of Anesthesiology, Faculty of Medicine, Chulalongkorn University, Bangkok.*
*** Department of Anesthesiology, Faculty of Medicine, Chiang Mai University, Chiang Mai.*
**** Department of Anesthesiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok.*
***** Department of Anesthesiology, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok.*
******** Department of Anesthesiology, Prince of Songkla University, Songkhla.*
******* Department of Anesthesiology, Khon Kaen University, Khon Kaen, Thailand*

Background and rationale : *The purposes of the Thai Anesthesia Incidents Study (THAI Study) of anesthetic outcomes were to survey patients, surgical, anesthetic profiles and determine factors related to adverse events.*
Material and Method : *A prospective descriptive study of occurrence screening was conducted in 20 hospitals comprised of 7 university, 4 general and 4 district hospitals across Thailand. Anesthesia personnel were required to fill up patient-related, surgical-related, anesthesia-related variables and adverse outcomes on a structured data entry form. The data were collected during the preanesthetic evaluation, intraoperative period and 24 hr postoperative period. Adverse events specific forms were used to record when they occurred. All data were keyed at data management unit with double entry technique and descriptive statistics was used in the first phase of this study.*
Results : *A total of 163403 consecutive cases were recorded during first 12 months. MD. anesthesiologists involved with 82%, 89%, 45% and 0.2% of cases in university hospitals, regional hospitals, general hospitals and district hospitals respectively. Nurse anesthetists took a major involvement in hospitals run by the Ministry of Public Health. Two-thirds of cases did not receive any premedication (67%) and midazolam was most frequent premedication administered (20%). Common monitoring were non invasive blood pressure (NIBP) (97%), pulse oximetry (96%), electrocardiography (80%), urine output (33%), airway pressure (27%) and capnometry (19%) respectively. The choices of anesthesia were general anesthesia (62%), spinal anesthesia (23%), total intravenous anesthesia (6%), monitor anesthesia care (4%), brachial plexus block (3%) and epidural anesthesia (1%). The adverse events were oxygen desaturation (31.9:10000), cardiac arrest (30.8:10000), death within 24 hr. (28.3:10000), difficult intubation (22.5:10000),re-intubation (19.4:10000), unplanned ICU admission (7.2:10000), coma/cva/convulsion (4.8:10000), equipment malfunction/failure (3.4:10000), suspected myocardial ischemia or infarction (2.7:10000), awareness during anesthesia (3.8:10000), late detected esophageal intubation (4.1:10000), failed intubation (3.1:10000), anaphylaxis or anaphylactoid reaction (2.1:10000), nerve injury (2:10000), pulmonary aspiration (2.7:10000), drug error (1.3:10000), hazard to anesthesia personnel (1.5:10000), unplanned hospital admission (0.1:10000), total spinal block (1.3:10000) and mismatch blood transfusion (0.18:10000)*
Conclusion : *Respiratory adverse events were common anesthesia direct related events. High incidence of cardiac arrest and death within 24 hr. highlighted concerns for prevention strategies. Incidents of adverse events can be used for institutional quality improvement, educational quality assurance and further research for patient safety in anesthesia.*

Keywords : *Anesthesia, Complications, Adverse events, Quality, Safety, Outcome*

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Currently there is a growing interest in the assessment of the quality of patient care with a particular emphasis on the outcome. One measure of quality has been to compare mortality rates across hospitals with adjustment for differences in patient case-mix. Studies of surgical patients and factors predicting mortality have not included anesthesia as a potential factor in operative deaths.[1,2,3,4] Anesthesia, unlike other medical or surgical specialties, does not usually constitute any treatment as it is inextricably linked to the surgical procedure. A question therefore arises : Can adverse outcome be applicable to anesthetic care?

There have been studies that examine the quality of care in anesthesia, especially with regard to outcome.[5, 6] Base upon the Thai Anesthesia Incidents Study (THAI Study)[7], a multicentered study among 20 hospitals across Thailand, initiated by the Royal College of Anesthesiologists of Thailand, the anesthesia profiles and outcomes were presented and analyzed in this study.

Material and Method

At 20 hospitals in Thailand from February 2003 to January 2004, data on patients populations, surgical procedure or site of operation, anesthesia profiles (personnels, monitoring, anesthesia techniques, anesthetics) and anesthesia related adverse outcomes were collected. The anesthesia profiles of these consecutive anesthetics consisted of anesthetic techniques, monitoring, airway equipments, anesthesia team, performer of intubation or regional anesthesia, anesthetics and anesthesia adverse events. The adverse events of interest were pulmonary aspiration, undiagnosed esophageal intubation, desaturation ($SpO_2 \leq 85$ or ≤ 90 for more than 3 minutes), re-intubation, difficult intubation (more than 3 times or duration of intubation longer than 10 min), failed intubation, total spinal block, awareness, coma/cerebrovascular accident/convulsion, nerve injuries, transfusion mismatch, suspected myocardial ischemia or infarction, cardiac arrest, death, suspected malignant hyperthermia, anaphylaxis/anaphylactoid reaction, drug error, anesthesia equipment malfunction or failure, anesthesia personnel hazard, unplanned hospital admission and unplanned intensive care unit (ICU) admission.

Correspondence to : Somrat Charuluxananan, Department of Anesthesiology, Faculty of Medicine, Chulalongkorn University, Rama IV Rd., Pathumwan, Bangkok 10330, Thailand. TEL (662) 2564215, (662) 2564295, FAX (662) 2541931, E-mail : somratcu@hotmail.com

Attending anesthesia personnels or site managers were asked to fill in the preplanned structured data entry form (form 1) in addition to the usual anesthetic record. Whenever the adverse events of interest occurred the details of events (except unplanned hospital and ICU admission) were recorded in events specific data entry form (form 2). For purposes of analysis, timing of adverse events was divided into three periods : intraoperatively, in the recovery room, or postoperatively (within 24 hr of operation).

All forms were reviewed by research nurse and/or the site manager for completeness. Corrections were then made by each centre including the verification of the major adverse event recorded. In addition, further data quality checks and the addition of the missing data were made at the end of the data collection period by the site manager.

Data collection and analysis. The data from each hospital were keyed at the data management centre with double entry technique to ensure the reliability of data entry. Descriptive statistics was used for calculation of the occurrence rates of anesthesia related adverse outcomes.

Results

We enrolled 163403 consecutive anesthetics during 12 months period (between Febuary 2003 to January 2004). Table 1 presents the number of cases involved with different anesthesia personnels stratified by type of hospitals Table 2 presents use of premedication. Monitoring during anesthesia stratified by type of hospitals is shown in Table3. General anesthesia, spinal anesthesia and total intravenous anesthesia were the three most common main anesthetic techniques with percentages of 62.2%, 23.7% and 5.7% respectively. Details of the choices of anesthetic techniques and combined techniques with general anesthesia are shown in Table 4 and 5. There were cases who received general anesthesia or total introvenous anesthesia due to failure or inadequate regional anesthesia and cases who received general anesthesia or TIVA due to regional anesthesia wear off. The numbers of patients who received hypotensive anesthesia, hypothermia technique and cardiopulmonary bypass (CPB) were 452 (0.3%), 1741 (1.2%) and 2691 (1.8%) respectively.

Regarding general anesthesia with endotracheal intubation, the numbers (%) of the first intubator an successful intubator are shown in Table 6. Details of airway equipment used are shown in Table 7. Most of the patients did not received special technique for intubation. Details of special technique for intubation

Table 1. Number of cases involved with anesthesia personnel stratified by types of hospitals

Type of hospitals	University hospital n = 98,839	Regional hospital n = 43,126	General hospital n = 19,536	District hospital n = 1,902
Anesthesiologists	81,339 (82.3%)	38,446 (89.1%)	8,833 (45.2%)	3 (0.2%)
Surgeons	3,369 (3.4%)	1,028 (2.4%)	10,197 (52.2%)	1,781 (93.6%)
Residents	56,910 (57.6%)	119 (0.3%)	21 (0.1%)	1 (0.05%)
Nurse Anesthetists	72,215 (73.1%)	42,751 (99.1%)	19,273 (98.7%)	1,884 (99.0%)
Medical students	8,430 (8.5%)	1,210 (2.8%)	47 (0.2%)	0 (0.0%)
Anesthesia nurse trainee	39,517 (40%)	2,801 (6.5%)	2 (0.01%)	0 (0.0%)

Value shown as number (%)

Table 2. Premedication stratified by types of hospitals

Type of hospitals	University hospital n = 98839	Regional hospital n = 43126	General hospital n = 19536	District hospital n = 1902	Total n = 163403
None	52,452 (53.1%)	40,902 (94.8%)	16,321 (83.5%)	1,290 (67.8%)	110,965 (67.9%)
Anticholinergic	797 (0.8%)	88 (0.2%)	74 (0.4%)	130 (6.8%)	1,089 (0.7%)
Midazolam	30,165 (30.5%)	1,057 (2.4%)	1,205 (6.2%)	445 (23.4%)	32,872 (20.1%)
Diazepam	17,499 (17.7%)	270 (0.6%)	468 (2.4%)	330 (17.3%)	18,567 (11.4%)
Ranitidine	1,783 (1.8%)	469 (1.1%)	1,347 (6.9%)	0 (0.0%)	8,599 (2.2%)

Value shown as number (%)

stratified by type of hospitals are shown in Table 8. Regarding the regional anesthesia, the number (%) of first performer and successful performer of regional anesthesia are shown in Table 9.

The anesthetics, neuromuscular blocking agents and reversal agents used among different groups of hospitals are shown in Table 10.

The anesthesia related adverse events stratified by types of hospitals are shown in Table 11. The order of adverse events from more common to less frequent classified by type of hospitals are demonstrated in Table 12. There were 5 cases of total spinal anesthesia reported in this study; 3 cases were cesarean section patients and 2 cases were extremities surgery patients who received spinal anesthesia conducted by MD. anesthesiologists and resident.

Table 3. Monitoring stratified by types of hospitals

	University hospital n = 98,839	Regional hospital n = 43,126	General hospital n = 19,536	District hospital n = 1,902	Total n = 163,403
NIBP	94,303 (94.4%)	42,872 (99.4%)	19,355 (99.1%)	1,889 (99.3%)	158,419 (96.9%)
MAP	8,271 (8.4%)	374 (0.9%)	366 (1.9%)	5 (0.3%)	9,016 (5.5%)
pulse oximeter	93,800 (94.9%)	42,513 (98.6%)	19,127 (97.9%)	1,705 (8.7%)	157,145 (96.2%)
EKG	79,610 (80.5%)	38,016 (88.1%)	11,839 (60.6%)	1,268 (6.5%)	130,733 (80.0%)
ET CO_2	25,024 (25.3%)	4,608 (10.7%)	1,728 (8.8%)	2 (0.0%)	31,362 (19.2%)
ET GAS	2,980 (3.0%)	2,385 (5.5%)	1,046 (5.3%)	0 (0.0%)	6,411 (3.9%)
urine output	35,470 (35.9%)	12,789 (29.7%)	6,100 (31.2%)	411 (2.1%)	54,770 (33.5%)
temperature	10,705 (10.8%)	147 (0.3%)	375 (1.9%)	0 (0.0%)	11,227 (6.9%)
esophageal stethoscope	3,618 (3.7%)	1,056 (2.4%)	1,464 (7.5%)	0 (0.0%)	6,138 (3.8%)
central venous pressure	6,687 (6.7%)	841 (1.9%)	78 (0.4%)	0 (0.0%)	7606 (4.7%)
precordial stethoscope	8249 (8.4%)	1,932 (4.5%)	476 (2.4%)	20 (0.1%)	10,677 (6.5%)
nerve stimulator	86 (0.1%)	0 (0.0%)	23 (0.1%)	0 (0.0%)	109 (0.1%)
airway pressure	31,071 (31.4%)	9,619 (22.3%)	3,751 (19.2%)	312 (1.6%)	44,753 (27.4%)
PAP	802 (0.8%)	2 (0.0%)	2 (0.0%)	0 (0.0%)	806 (0.5%)
cardiac output	155 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	155 (0.1%)

Value shown as number (%)

Discussion

This multicentered national study on anesthesia related adverse outcome in Thailand covers 163,403 anesthetic cases over a 12-months period from February 2003 to January 2004 showed description of methodology and population characteristics.[7] During early Phase I of the study we enrolled all consecutive patients to study incidence of adverse events of interest and developed events specific data collection forms (form 2) for studying in details of each anesthesia ad-verse events. Therefore we continued the occurrence screening technique to gather data for analysis of fac-tors related to anesthesia related complications after the first 12 months period. These results of the outcome analyses will be presented in subsequent manuscripts.

The number of cases involved with anesthesia personnel were different between type of hospitals. In university hospitals, three most frequent involved personnels were anesthesiologists (82.3%), nurse anes-thetists (73.1%) and residents (57.6%). There were also different proportion of anesthesia personnel involved in each university hospitals (data was not shown) because of institutional different policy. The three most frequent involved anesthesia personnel in tertiary or regional hospitals were anesthesiolo-

Table 4. Main anesthetic technique stratified by types of hospitals

	University hospital	Regional hospital	General hospital	District hospital	Total
GA	60,583 (63.8%)	25,268 (58.9%)	11,836 (61.6%)	1,184 (62.9%)	98,871 (62.2%)
GA(TIVA)	4,967 (5.2%)	1,546 (3.6%)	2,313 (12.0%)	242 (12.9%)	9,068 (5.7%)
MAC	3,326 (3.5%)	1,711 (4.0%)	830 (4.3%)	50 (2.7%)	5,917 (3.7%)
Spinal	21,511 (22.7%)	12,206 (28.5%)	3,676 (19.1%)	344 (18.3%)	37,737 (23.7%)
Epidural	1,790 (1.9%)	52 (0.1%)	19 (0.1%)	4 (0.2%)	1,865 (1.2%)
CSE	156 (0.2%)	25 (0.06%)	0 (0.0%)	0 (0.0%)	181 (0.1%)
Caudal	36 (0.04%)	0 (0.0%)	0 (0.0%)	9 (0.3%)	45 (0.03%)
Brachial plexus block	2,325 (2.4%)	1,912 (4.5%)	249 (1.3%)	0 (0.0%)	4,486 (2.8%)
Nerve block	5 (0.005%)	0 (0.0%)	1 (0.005%)	0 (0.0%)	6 (0.01%)
Bier block	259 (0.3%)	174 (0.4%)	299 (1.6%)	49 (2.6%)	781 (0.5%)
Total	**94,958 (100.0%)**	**42,894 (100.0%)**	**19,223 (100.0%)**	**1,882 (100.0%)**	**158,957 (100.0%)**

Value shown as number (%)

Table 5. Combined technique with general anesthesia

	University hospital	Regional hospital	General hospital	District hospital
Non-combined	93,035 (90.6%)	42,186 (97.8%)	19,275 (98.7%)	1,883 (99.0%)
Epidural block	2,033 (2.02%)	150 (0.3%)	2 (0.01%)	0 (0.0%)
Caudal block	6,491 (6.3%)	125 (0.3%)	11 (0.06%)	0 (0.0%)
Brachial plexus block	215 (0.2%)	35 (0.08%)	11 (0.06%)	0 (0.0%)
Nerve block	551 (0.5%)	383 (0.9%)	20 (0.1%)	0 (0.0%)
Local/Topical	334 (0.3%)	244 (0.6%)	216 (1.1%)	19 (1.0%)
Total	102,659 (100.0%)	43,123 (100.0%)	19,535 (100.0%)	1,902 (100.0%)

Value shown as number (%)

Table 6. Number (%) of first intubator and successful intubator of general anesthesia with endotracheal intubation

	University hospital		Regional hospital		General hospital		District hospital		Total	
	First	Successful	First	Successful	First	Successful	First	Successful	First	Successful
Anesthesiologist	5,772 (11.0%)	7,267 (14.1%)	5,020 (24.7%)	5,475 (26.9%)	361 (3.4%)	444 (4.2%)	0 (0.0%)	0 (0.0%)	11,153 (13.2%)	13,186 (15.7%)
Surgeon	225 (0.4%)	228 (0.4%)	31 (0.1%)	40 (0.2%)	47 (0.4%)	52 (0.5%)	7 (0.6%)	14 (1.2%)	310 (0.4%)	334 (0.4%)
Resident	24,266 (46.6%)	23,811 (46.1%)	38 (0.2%)	37 (0.2%)	4 (0.04%)	5 (0.05%)	0 (0.0%)	0 (0.0%)	24,308 (28.8%)	23,853 (28.5%)
Nurse anesthetist	3,563 (6.8%)	3,591 (7.0%)	13,888 (68.3%)	13,699 (67.3%)	10,254 (95.9%)	10,109 (95.1%)	1,160 (99.4%)	1,147 (98.8%)	28,865 (34.3%)	28,546 (34.1%)
Medical student	3,063 (5.9%)	2,628 (5.0%)	576 (2.8%)	453 (2.2%)	28 (0.3%)	21 (0.2%)	0 (0.0%)	0 (0.0%)	3,667 (4.3%)	3,102 (3.7%)
Anesthesia nurse trainee	151,178 (29.2%)	14,097 (27.3%)	787 (3.9%)	656 (3.2%)	3 (0.03%)	2 (0.02%)	0 (0.0%)	0 (0.0%)	15,968 (18.9%)	14,755 (17.6%)
Total	**52,067 (100%)**	**51,622 (100%)**	**20,340 (100%)**	**20,360 (100%)**	**10,697 (100%)**	**10,633 (100%)**	**1,167 (100%)**	**1,161 (100%)**	**84,271 (100%)**	**83,776 (100%)**

Value shown as number (%)

Table 7. Usage of airway equipments stratified by types of hospitals

	University hospital n = 98,839	Regional hospital n = 43,126	General hospital n = 19,536	District hospital n = 1,902	Total n = 163,403
Orotracheal	50,929 (51.5%)	21,644 (50.2%)	10,599 (54.2%)	1,113 (58.5%)	84,285 (51.6%)
Nasotracheal	1,519 (1.5%)	758 (1.8%)	227 (11.7%)	3 (0.2%)	2,507 (1.5%)
Tracheostomy	2,018 (2.0%)	535 (1.2%)	111 (0.6%)	6 (0.3%)	2,670 (1.6%)
LMA	2,155 (2.2%)	581 (1.3%)	19 (0.1%)	0 (0.0%)	2,755 (1.7%)
Under Mask	4,358 (4.4%)	3,055 (7.0%)	1,272 (6.5%)	23 (1.2%)	8,708 (5.3%)
Double lumen	568 (0.6%)	58 (0.1%)	7 (0.03%)	0 (0.0%)	633 (0.4%)
Bronchoscope	967 (1.0%)	241 (0.6%)	68 (0.3%)	0 (0.0%)	1,276 (0.8%)
Jet	512 (0.5%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	512 (0.3%)
Oral airway	20,232 (20.5%)	6,005 (13.9%)	2,242 (11.5%)	403 (21.2%)	28,882 (17.7%)
Nasal airway	301 (0.3%)	37 (0.08%)	16 (0.08%)	0 (0.0%)	354 (0.2%)
O_2supplement	19,006 (19.2%)	12,312 (28.5%)	5,513 (28.2%)	214 (11.3%)	37,045 (22.7%)

Value shown as number (%)

Table 8. Special intubation technique among different types of hospitals

	University hospital	Regional hospital	General hospital	District hospital	Total
None	70,169 (90.1%)	31,626 (79.8%)	12,946 (78.9%)	862 (54.6%)	115,603 (85.3%)
Rapid sequence					
With cricoid pressure	6,364 (8.2%)	6,465 (16.3%)	3,254 (19.8%)	669 (42.3%)	16,752 (12.5%)
Without cricoid pressure	791 (1%)	1,316 (3.3%)	193 (1.2%)	49 (3.1%)	2,349 (1.7%)
Awake	170 (0.2%)	140 (0.4%)	11 (0.07%)	0 (0.0%)	321 (0.2%)
Fiberoptic	289 (70.4%)	74 (0.2%)	6 (0.04%)	0 (0.0%)	369 (0.3%)
Blind nasal	67 (0.09%)	4 (0.01%)	1 (0.001%)	0 (0.0%)	72 (0.05%)

Value shown as number (%)

Table 9. First performer and successful performer of regional anesthesia

	University hospital		Regional hospital		General hospital		District hospital		Total	
	First	Successful	First	Successful	First	Successful	First	Successful	First	Successful
Anesthesiologist	7,925 (28.3%)	8,864 (31.8%)	13,559 (57.1%)	13,632 (95.8%)	2,250 (52.1%)	2,265 (52.9%)	3 (0.8%)	2 (0.5%)	23,737 (50.0%)	24,763 (53.0%)
Surgeon	1,153 (4.0%)	1,143 (4.1%)	237 (6.3%)	229 (1.6%)	2,005 (46.5%)	1,984 (46.3%)	369 (98.9%)	365 (99.2%)	3,764 (8.0%)	3,721 (8.0%)
Resident	16,806 (60.0%)	16,086 (57.8%)	50 (0.3%)	44 (0.4%)	6 (0.1%)	3 (0.07%)	1 (0.2%)	1 (0.3%)	16,863 (36.0%)	16,134 (35.0%)
Medical student	2,169 (7.7%)	1,746 (6.3%)	420 (15.9%)	321 (2.2%)	55 (1.3%)	30 (0.7%)	0 (0.0%)	0 (0.0%)	2,644 (6.0%)	2,097 (4.0%)
Total	**28,053 (100%)**	**27,839 (100%)**	**14,266 (100%)**	**14,226 (100%)**	**4,316 (100%)**	**4,282 (100%)**	**373 (100%)**	**368 (100%)**	**47,008 (100%)**	**46,715 (100%)**

Value shown as number (%)

Table 10. Anesthetic and neuromuscular blocking agents stratified by types of hospitals

	University hospital **n = 98,839**	**Regional** hospital **n = 43,126**	**General** hospital **n = 19,536**	**District** hospital **n = 1,902**	**Total** **n = 163,403**
Pentothal	69,94(7.1%)	2,640(6.1%)	974(5.0%)	197(10.4%)	10,805(6.6%)
Propofol	49,221(49.8%)	21,048(48.8%)	9,691(49.6%)	961(50.5%)	80,921(49.5%)
Ketamine	2,700(2.7%)	1,492(3.5%)	4,174(21.4%)	282(14.8%)	8,648(5.3%)
Midazolam	25,392(25.7%)	5,501(12.8%)	5,938(30.4%)	102(5.4%)	36,933(22.6%)
Diazepam	4,654(4.7%)	1,738(4.0%)	2,476(12.7%)	890(46.8%)	9,758(6.0%)
Succinycholine	18,836(19.1%)	1,738(4.0%)	2,476(12.7%)	890(46.8%)	9,758(6.0%)
Pancuronium	21,890(22.1%)	4,414(10.2%)	1,494(7.6%)	850(44.7%)	28,648(17.5%)
Atracurium	13,227(13.4%)	6,936(16.1%)	1,177(6.0%)	217(11.4%)	21,557(13.2%)
Cisatracurium	5,002(5.1%)	1,381(3.2%)	3,796(19.4%)	0(0.0%)	10,179(6.2%)
Vecuronium	9,329(9.4%)	5,687(13.2%)	2,824(14.5%)	97(5.0%)	17,937(11.0%)
Mivacurium	1,157(1.2%)	280(0.6%)	34(0.2%)	0(0.0%)	1,471(0.9%)
Rocuronium	3,286(3.3%)	876(2.0%)	323(1.7%)	0(0.0%)	4,485(2.7%)
Nitrous oxide	53,555(54.2%)	23,925(55.5%)	11,422(58.5%)	1,179(62.0%)	90,081(55.1%)
Halothane	20,074(20.3%)	11,935(27.7%)	7,112(36.4%)	480(25.2%)	39,601(24.2%)
Isoflurane	34,340(34.7%)	9,185(21.3%)	1,430(7.3%)	77(4.0%)	45,032(27.6%)
Sevoflurane	9,265(9.4%)	4,696(10.9%)	3,291(16.8%)	153(8.0%)	17,405(10.6%)
Desflurane	41(0.04%)	79(0.2%)	0(0.0%)	0(0.0%)	120(0.07%)
Morphine	2,5342(25.6%)	11,904(27.6%)	4,834(24.7%)	339(17.8%)	42,419(25.9%)
Fentanyl	45,673(46.2%)	15,023(34.8%)	8,269(42.3%)	771(40.5%)	69,736(42.8%)
Pethidine	5,358(5.4%)	3,455(8.0%)	962(4.9%)	173(9.0%)	9,948(6.0%)
Nalbuphine	178(0.2%)	4(0.01%)	0(0.0%)	0(0.0%)	182(0.1%)
Lidocaine	11,212(11.3%)	4,538(10.5%)	3,655(18.7%)	444(23.3%)	19,849(12.1%)
Bupivacaine	25,924(26.2%)	13,117(30.4%)	3,756(19.2%)	352(18.5%)	43,149(26.4%)
Ropivacaine	149(0.1%)	39(0.1%)	10(0.05%)	0(0.0%)	198(0.1%)
Levobupivacaine	7(0.007%)	0(0.0%)	0(0.0%)	0(0.0%)	7(0.004%)
Prostigmine+Atropine	37,280(37.7%)	15,752(36.5%)	8,928(45.7%)	1,073(56.4%)	63,033(38.6%)

Value shown as number (%)

gists (89.1%), nurse anesthetists (99.1%) and anesthesia nurse trainees (6.5%) respectively. These data revealed that personnel in training took important role in anesthesia services especially residents in university hospitals and anesthesia nurse trainees in tertiary hospitals. In general hospitals, the three most frequent anesthesia personnel involved were nurse anesthetists (98.7%), surgeons (52.2%) and anesthesiologists (45.2%) respectively. This was very interesting because surgeons also played major roles in anesthesia services. This may be due to the following reasons : (1) lack of anes-thesiologists in several general hospitals[8] (2) regional anesthesia was legally permitted to be conducted by MD. doctor. This was correspondent with the most frequent personnel involved in district hospitals; nurse anesthetists (99.0%) and surgeons (93.6%).

Most patients received no premedication before surgery. Premedication was more frequently pres-cribed in university hospitals (46.9%), while the percen-tage of patients receiving premedication in hospitals run by the Ministry of Public Health s hospitals varied between 5.2% to 22.2%. The most common preme-dication was benzodiazepine particularly midazolam.

The purpose of monitoring during anesthesia is to augment the clinical observation of attending anes-thesia personnel and to help them decide on the administration of anaesthesia and other treatments. The study revealed that noninvasive blood pressure monitoring or NIBP (96.9%) and pulse oximeter (96.2%) were the most common monitoring used during anesthesia. Some patients had not been monitored under NIBP because they were monitored with mean arterial pressure monitoring. Due to high compliance of pulse oximeter monitoring, the Royal College of Anesthe-siologists of Thailand has just

Table 11. Adverse outcome stratified by types of hospitals

	University hospital n = 98839	Regional hospital n = 43126	General hospital n = 19536	District hospital n = 1902	Total n = 163403	Incidence per 10000	(95% CI)
Pulmonary Aspiration	23 (79.3%)	3 (10.3%)	3 (10.3%)	0 (0.0%)	29 (100.0%)	2.7*	1.7-3.7
Esophageal Intubation	15 (34.0%)	26 (59.0%)	3 (7.0%)	0 (0.0%)	44 (100.0%)	4.1*	2.8-5.3
Desaturation	328 (62.0%)	160 (30.7%)	35 (6.7%)	3 (0.6%)	521 (100.0%)	31.9	29.2-34.6
Re-intubation	155 (74.2%)	43 (20.6%)	9 (4.3%)	2 (1.0%)	209 (100.0%)	19.4*	16.7-22.0
Difficult Intubation	179 (73.7%)	41 (16.9%)	22 (9.1%)	1 (0.4%)	243 (100.0%)	22.5*	19.7-25.3
Failed Intubation	26 (76.5%)	6 (17.6%)	0 (0.0%)	2 (5.9%)	34 (100.0%)	3.1*	2.1-4.2
Total Spinal Block	2 (40.0%)	0 (0.0%)	3 (60.0%)	0 (0.0%)	5 (100.0%)	1.3**	0.2-2.5
Awareness (during GA)	35 (85.4%)	6 (15.0%)	0 (0.0%)	0 (0.0%)	41 (100.0%)	3.8*	2.6-5.0
Coma/CVA/Convulsion	60 (76.9%)	8 (10.3%)	10 (12.8%)	0 (0.0%)	78 (100.0%)	4.8	3.7-5.8
Nerve Injuries	27 (84.4%)	5 (15.6%)	0 (0.0%)	0 (0.0%)	32 (100.0%)	2.0	1.3-2.6
Transfusion Mismatch	3 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100.0%)	0.18	0.1-0.5
Suspected MI / Ischemia	40 (88.9%)	4 (8.9%)	1 (2.2%)	0 (0.0%)	44 (100.0%)	2.7	1.9-3.5
Cardiac Arrest	212 (42.1%)	224 (44.4%)	68 (13.5 %)	0 (0.0%)	504 (100.0%)	30.8	28.2-33.5
Death	171 (37.0%)	225 (48.7%)	66 (14.3%)	0 (0.0%)	462 (100.0%)	28.3	25.7-34.8
Suspected Maligant Hyperthermia	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.0	-
Anaphylaxis / Anaphylactoid reaction	17 (50.0%)	11 (32.4%)	2 (5.9%)	4 (11.8%)	34 (100.0%)	2.1	1.4-2.8
Drug Error	16 (72.7%)	5 (22.7%)	1 (4.5%)	0 (0.0%)	22 (100.0%)	1.3	0.8-1.9
Equipment Malfunction/ Failure	25 (44.6%)	25 (44.6%)	5 (8.9%)	1 (1.8%)	56 (100.0%)	3.4	2.5-4.3
Anesthesia Personnel Hazard	3 (12.5%)	17 (70.8%)	4 (16.7%)	0 (0.0%)	24 (100.0%)	1.5	0.9-2.1
Unplanned Hospital Admission	16 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	16 (100.0%)	1.0	0.5-1.5
Unplanned ICU Admission	69 (59.0%)	31 (26.5%)	17 (14.5%)	0 (0.0%)	117 (100.0%)	7.2	5.9-8.5

Value shown as number (%)
*calculated from total cases of general anesthesia (n=107939)
**calculated from total cases of spinal anesthesia (n=37737)

changed its wording in the recommendations for clinical use of pulse oximeter from should to must . [9] Other monitoring procedu-res were, namely, electrocardiography or EKG (80.0%) urine output monitoring (33.5%), capnometery or ET CO_2 monitoring (19.2%) and temperature measurement (6.9%) respectively. Some monitoring equipments such as capnometry and end tidal gas monitor were expen-sive. Regarding invasive monitoring, mean arterial pressure monitoring was the most common (5.5%) campared to central venous pressure (4.7%), pulmona-ry arterial pressure or PAP (0.5%) and cardiac output monitoring (0.1%). The use of invasive monitoring was more frequent in university and tertiary hospitals because of severity of disease and training purposes. Peripheral nerve stimulator was scarcely used (0.1%).

The main anesthetic technique or choice of anesthesia for surgery in this study were particularly conducted with general anesthesia including total intravenous anesthesia (67.9%), spinal anesthesia (23.7%) monitor anesthesia care or MAC (2.8%), brachial plexus block (2.8%) and epidural anesthesia (1.2%) respectively. Regional anesthesia had a limitation of sites of operation,only legally permitted for MD. doctors and individual preference. In hospitals where there was no anesthesiologist, surgeons had to perform regional anesthesia by themselves ; and the patients were subsequently monitored by nurse anesthetists.

Table 12. Order of frequency of total anesthesia related adverse events stratified by types of hospitals from more to less frequency

All hospitals	University hospital	Regional hospital	General hospital	District hospital
1. Desaturation	1	3	3	2
2. Cardiac Arrest	2	2	1	-
3. Death with in 24 hr.	4	1	2	-
4. Difficult Intubation	3	5	4	5
5. Re-intubation	5	4	7	3
6. Unplanned ICU Admission	6	6	5	-
7. Coma / CVA / Convulsion	7	11	6	-
8. Equipment Malfunction / Failure	12	8	8	5
9. Suspected MI / Ischemia	8	16	14	-
10. Esophageal Intubation	17	7	10	-
11. Awareness	9	12	-	-
12. Failed Intubation	11	12	-	3
13. Anaphylaxis / Anaphylactoid reaction	14	10	13	1
14. Nerve Injuries	10	14	-	-
15. Pulmonary Aspiration	13	17	10	-
16. Anesthesia Personnel Hazard	18	9	9	-
17. Drug Error	15	14	14	-
18. Unplanned Hospital Admission	15	-	-	-
19. Total Spinal Block	18	-	10	-
20. Transfusion mismatch	20	-	-	-

Value shown as order of frequency

Spinal anesthesia was the most common regional anesthetic technique conducted in every types of hospitals. No brachial plexus block was performed in district hospitals. The frequencies of conduction of epidural anesthesia were quite low (1.2%), mostly done in university hospitals simply for training purposes. This study had not included anesthesia in private hospital where epidural anesthesia might be more popular for purpose of postoperative analgesia. Caudal anesthesia was combined with general anesthesia particularly in pedriatric anesthesia. Epidural anesthesia was also another choice combined with general anesthesia for providing neuraxial opioids. There were few cases (less than 1%) of general anesthesia due to failure or inadequate analgesia after regional anesthesia. General anesthesia was more frequently conducted after anal-gesia effect of regional anesthesia was found wearing off.

Most anesthetic cases (88.1%) were performed without special technique during anesthesia. Cardio-pulmonary bypass was done only in university hospi-tals during study period. This can represent some ad-ministrative problems in some regional hospitals where open heart surgery can not be performed. For establis-ment of cardiothoracic surgery in these hospitals, anesthesiologists should attend refresher course or have further training. Hypotensive anesthesia was performed in every types of hospitals except in district hospitals. Hypothermia was mostly conducted in university hos-pitals.

Orotracheal tube was the most common airway equipment used in all groups of hospitals. Undermask ventilation (5.3%) was more frequently performed than laryngeal mask airway or LMA(1.7%). This study revealed that general anesthesia with LMA was not commonly conducted in Thailand. This may be due to its high cost of airway equipment and attending personnel perference. However, LMA is reusable after re-sterilization. This airway equipment may be more popular in the future because of increasing ambulatory surgery service. Bronchoscope and double lumen endobronchial tube were uncommonly used in all groups of hospitals except district hospitals. Jet ventilation was used only in university hospital particularly in anesthesia for ear-nose-throat surgery.

The technique of rapid sequence induction intubation was performed with cricoid pressure (12.5%) and without cricoid pressure (1.7%). Other special intubation technique performed were fiberoptic intu-bation (0.3%), awake intubation (0.2%) and blind nasal intubation (0.05%) respectively.

The proportions of first performers of intubation and performers with successful intubation corresponded to the proportions of cases involved by anesthesia personnel stratified by types of hospitals. The three most frequent performers of intubation were namely nurse anesthetists (34.3%), residents (28.8%) and anesthesia nurse trainee (18.9%). Medical students were performers of intubation mostly in university and tertiary hospital because tertiary hospitals also serve as regional medical schools under the Ministry of Public Health. Educational quality assurance may be a tool for the improvement of the quality of anesthesia in these regional medical school including staffing policy, curriculum, equipments and budgetting.

First performers of regional anesthesia were anesthesiologists (50.0%), residents (8.0%), surgeon (8.0%) and medical students (6.0%), respectively. Surgeons were the first performer of regional anesthesia in high percentages both in general (46.5%) and district hospital (98.9%). This was also due to the lack of anesthesiologist in those hospitals. Residents performed regional anesthesia at high percentage (60.0%) of cases in university hospitals due to of training purpose. Number of cases should be used for quality assurrance activity in training centers.[10]

The three most common intravenous anesthetics used during the study were propofol (49.5%), midazolam (22.6%) and pentothal (6.6%). Pentothal was administered less frequently because of a shortage of the drug in Thailand during the study. Ketamine was administered only for 5.3% by anesthesia personnel.

Succinyl choline was administered for intubation in only 6.0% because shortage of succinyl choline. The three most common non-depolarizing muscle relaxants were pancuronium (17.5%), atracurium (13.2%) and vecuronium (11.0%), respectively. Cisatracurium was most frequently administered in general hospital (19.4%). This might be due to cisatracurium was more popular among nurse anesthetists in hospitals where there was no MD. anesthesiologists.

Inhalational anesthetics were used in the following orders : isoflurane (27.6%), halothane (24.2%), sevorane (10.6%) and desflurane (0.07%), respectively. Similarly sevorane was administered at 16.8% which was considered high in general hospital.

The three most common narcotics used were, namely fentanyl (42.8%), morphine (25.9%), pethidine (6.0%) and nalbuphine (0.1%) respectively.

Bupivacaine was the most common (26.4%) local anesthetics administered when lidocaine was less frequently used due to no spinal lidocaine availability after study about neurodeficit.[11] Ropivacaine was rarely administered and now it is not commercially available in Thailand. Levobupivacaine was initially administered in researches in university hospitals.

Monitoring of adverse outcomes and reporting was originally described by Flanagan in 1954[12]. The concept arose from studies in the Aviation Psychology Program of the United States Air Force during and after the Second World War. In 1978 Cooper and colleagues applied a technique of critical incident analysis tech-nique to anesthesia.[13] They modified the definition given by Flanagan, such that an incident became a cri-tical incident when it was clearly an occurrence that could have led (if not discovered or corrected in time) or did lead to an undesirable outcome, ranging from increased length of hospital stay to death or permanent disability. In order to analyse adverse outcomes in multicentered study, it is essential to have an agreed, set of terms to describe adverse outcomes. Our interesting outcomes or indicators were accepted as relevant to patient outcome by consensus of the principal investigator. Some indicators such as cardiac arrhythmia or abnormal blood pressure values were consi-dered unreliable and were deleted. These were similar to study of Katz et al.[14] Studies of anesthetic complica-tions were regularly published.[15,16,17,18] To determine the prevalence of anesthetic complications, large sample sizes are required, as such complications are rare events.[19] The incidents of anesthetic complication in this study was 2,366 out of 163,403 (1.44%) while the reported incidence varied between 0.06%[16] and 10.6%.[15]

Respiratory complications remain one of the most important areas of concern regarding major morbidity and mortality related to anesthesia. This study revealed 29 cases of pulmonary aspiration or incidence of 2.7:10000 which was similar to incidence in Scandinavia[20,21] and the United States of America.[22] The incidence of esophageal intubation was 3.7:10000 which was less frequent than that reported by Stewart RD et al[23]. This could be explained by the following ; 1) different definition were used (late detected vs actual detected 2) different setting (operating room vs field intubation by paramedical personnel). Reintubation rate of 0.19% agreed with previous studies.[23,24]

This study showed 0.22% rate of unanticipated difficult intubation while the reported incidents varied between 1.5-8.5%.[25] The incidence of failed intubation varied between 0.13-0.5%[25,26] while this study revealed an incidence rate of 0.03%. Desaturation was the most common adverse events occurred in this study with an incidence rate of 31.9 per 10000 anesthetics. The definition of desaturation in this study were : 1) oxygen saturation was equal to or less than 85% at any period ; 2) oxygen saturation decreased to 90% or less for at least 3 minutes ; or 3) oxygen saturation decreased for at least 15% in congenital cyanotic heart disease patient. This high incidence of desaturation supports the Royal College of Anesthesiologists of Thailand to change pulse oxymetry to be standard for basic intraoperative monitoring in the kingdom.

Cardiac arrest and deaths were the second and third most common adverse events in our study. There were 504 cases of cardiac arrest (30.8 per 10000 or 1:325) and 462 deaths (28.3 per 10000 or 1:353) which did not occur in district hospitals because high risk patients or major surgery were refered to larger medical centers. This is similar to Mckenzie s report on perioperative mortality rate of 1:388 anesthetics[27], and Lagasse s review of overall perioperative mortality rate of approximately 1:500 anesthetics.[28] However, anesthesia related mortality rates have decreased from 2 deaths per 10000 anesthetics administered in 1980 to about 1 death per 200000 to 300000 anesthetics as reported by the Committee on Quality of Healthcare in America.[29] The wide range of the difference of perioperative mortality rates are probably caused by differences in operational definitions and reporting sources, as well as a lack of appropriate risk stratification. Anesthesia attributable to mortality or preventable mortality will be presented in a subsequent report.

Suspected myocardial ischemia or infarction was defined by definite or suspected condition as evidence of change of electrocardiogram such as ST segment changes and/or clinical chest pain and/or elevated cardiac enzyme and/or diagnosed by echocardiogram according to institutional set up. Our study showed 44 cases out of 163,403 anesthetics or 2.7:10000 that agrees with incidence of 0.03-4% from previous reports.[30,31]

There were five cases of total spinal block in our study, there cases confined to total spinal block without progressing to cardiac arrest or death. There were other 2 cases of total spinal block with death within 24 hr postoperative period judged by 3 peer reviewers.

Awareness during general anesthesia is a frightening experience for the patient, which may result in serious emotional injury and post-traumatic stress disorder.[32,33] This study revealed an incidence of 0.38% which is correspondant to previous study of awareness with recall during anesthesia.[34,35,36] There were 78 cases of coma or cerebrovascular accidents or convulsion with incidence of 4.7 per 10000 anesthetics during the first period of the THAI Study. These were important according to a report of the American Society of Anesthesiologists Closed Claims Project that nervous system injury, such as nerve injury and brain damage, posted 18% and 12% of claims during the 1980 s to the mid 1990 s.[37] The incidence of 2 per 10000 anesthetics of nerve injury in our study prompted us to study the contributing factors in the second phase of study.

There were 3 cases of mismatch blood transfusion which will be described in subsequent manuscript. During first phase of this study, there was no report of suspected malignant hyperthermia during the first 12 months of the study. However we continued to have surviellance of malignant hyperthermia to be our baseline data in Thailand.

Anaphylaxis or anaphylactoid reaction in our study occurred with an incidence of 2 per 10000 anesthetic which agrees with 1 : 4600 procedures from McKinnon RP s study.[38] Twenty-two events of drug error or incidence of 1.4 per 10000 anesthetics during first 12 months was quite low. The explanation of this underestimation is that most drug errors are near miss incidents which require self-reporting mind to comply with our structured data entry form. The incidence of equipment malfunction (3.4 per 10000) and hazards to anesthesia personnel (0.8 per 10000) were quite low. These might need audit system and workshop to improve the compliance of anesthesia-related adverse outcome recording system. Unplanned hospital admission (incidence of 0.8 per 10000) and unplanned ICU admission (incidence of 7.2 per 10000) were indices for quality improvement activity in each instititue.

In summary the majority of adverse events occurred in all types of hospitals was respiratory problem. In large hospitals, oxygen desaturation, cardiac arrest and death were three most frequent adverse events which need further detailed study to seek for preventable measures and system to decrease these catastrophic incidents. Respiratory complications were major problems directly related to anesthesia in all groups of hospitals. The baseline incidence of adverse outcomes can be used for quality improvement, construction of clinical prac-tice guidelines, improvement

of education for medical students, nurse anesthetist and anesthesia training programs and for further researches, all of which will be appropriate for Thailand.

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การศึกษาอุบัติการณ์เกิดภาวะแทรกซ้อนทางวิสัญญีในประเทศไทย (THAI Study): II ข้อมูลเกี่ยวกับวิสัญญีและภาวะแทรกซ้อน

สมรัตน์ จารุลักษณานันท์, ยอดยิ่ง ปัญจสวัสดิ์วงศ์, สุวรรณี สุรเศรณีวงศ์, สุรีรัตน์ ศรีสวัสดิ์, อรนุช เกี่ยวข้อง, ฐิติมา ชินะโชติ, ธวัช ชาญชยานนท์, มะลิ รุ่งเรืองวานิช, สมบูรณ์ เทียนทอง, โฉมชบา สิรินันทน์, อรลักษณ์ รอดอนันต์

ที่มาและเหตุผล: *โครงการศึกษาอุบัติการณ์เกิดภาวะแทรกซ้อนทางวิสัญญีในประเทศไทย (THAI Study) มีวัตถุประสงค์เพื่อศึกษาข้อมูลเกี่ยวกับผู้ป่วย การผ่าตัด และการให้ยาระงับความรู้สึกในการหาปัจจัยเกี่ยวข้องกับการเกิดภาวะแทรกซ้อนทางวิสัญญี*

วัสดุและวิธีการ: *เป็นการศึกษาแบบพรรณนาชนิดไปข้างหน้าแบบคัดกรองอุบัติการณ์ในผู้ป่วยทุกรายที่ได้ยาระงับความรู้สึกในโรงพยาบาล 20 แห่ง (โรงพยาบาลมหาวิทยาลัย 7 แห่ง, โรงพยาบาลตติยภูมิ 5 แห่ง, โรงพยาบาลทั่วไป 4 แห่ง และโรงพยาบาลชุมชน 4 แห่ง) จากทุกภูมิภาคของประเทศไทย ทำการกรอกข้อมูลที่เกี่ยวกับผู้ป่วย ข้อมูลทางศัลยกรรม และข้อมูลทางวิสัญญีและภาวะแทรกซ้อนที่เกิดขึ้นระหว่างผ่าตัด จนถึงหลังผ่าตัด 24 ชั่วโมง ในแบบฟอร์มมาตรฐาน ในกรณีที่เกิดภาวะแทรกซ้อนบางประการจะทำการเก็บข้อมูลในแบบฟอร์มเฉพาะเรื่องที่หน่วยจัดการข้อมูลด้วยวิธีการกรอกข้อมูล 2 ครั้ง และใช้สถิติสำหรับข้อมูลแบบพรรณนาสำหรับการศึกษา ในขั้นต้น*

ผลการศึกษา: *ข้อมูลผู้ป่วยทั้งหมด 163403 รายที่ได้ยาระงับความรู้สึกใน 12 เดือนแรกของการศึกษาวิสัญญีแพทย์เป็นผู้รับผิดชอบการให้ยาระงับความรู้สึกในโรงพยาบาลมหาวิทยาลัย 82% ในโรงพยาบาลตติยภูมิ 89% โรงพยาบาลทั่วไป 45% และในโรงพยาบาลชุมชน 0.2% วิสัญญีพยาบาลเป็นผู้ให้ยาระงับความรู้สึกเป็นส่วนใหญ่ ในโรงพยาบาลของกระทรวงสาธารณสุข ร้อยละ 67 ของผู้ป่วยไม่ได้รับยาก่อนให้ยาระงับความรู้สึก ในขณะที่มิดาโซแลมเป็นยากล่อมประสาทที่ให้ก่อนให้ยาระงับความรู้สึกที่นิยมใช้มากที่สุด (20%) การเฝ้าระวังที่ใช้ ได้แก่ การวัดความดันโลหิต (97%) การวัดระดับความอิ่มตัวของออกซิเจน (96%) การวัดคลื่นไฟฟ้าหัวใจ (80%) การวัดปริมาณปัสสาวะ (33%) การวัดความดันในทางเดินหายใจ (27%) และการวัดระดับคาร์บอนไดออกไซด์ในลมหายใจออก (19%) วิธีการให้ยาระงับความรู้สึกตามลำดับจากมากไปน้อย ได้แก่ ดมยาสลบทั้งตัว (62%), การฉีดยาเข้าไขสันหลัง (23%), การดมยาสลบทั้งตัวโดยฉีดเข้าหลอดเลือดดำ (6%), การให้บริการวิสัญญีแบบเฝ้าระวัง (4%) การฉีดยาชาเฉพาะส่วนที่กลุ่มประสาทเบรเคียล (3%) และการฉีดยาชาเข้าชั้นนอกดูรา (1%) โดยภาวะแทรกซ้อนที่เกิดขึ้น ได้แก่ ภาวะระดับความอิ่มตัวของออกซิเจนต่ำ (31.9:10000) หัวใจหยุดเต้น (30.8:10000), เสียชีวิตภายใน 24 ชั่วโมง (28.3:10000) การใส่ท่อหายใจยาก (22.5:10000) การใส่ท่อหายใจซ้ำ (19.4:10000) การเข้าหออภิบาลผู้ป่วยหนักโดยไม่ได้วางแผนไว้ก่อน (7.2:10000) ภาวะโคม่า, อุบัติเหตุของระบบเส้นเลือดสมอง หรือชัก (4.8:10000) เครื่องมือเกี่ยวกับวิสัญญีผิดปกติ หรือใช้ไม่ได้ (3.4:10000) สงสัยเกิดภาวะกล้ามเนื้อหัวใจตายหรือขาดเลือด (2.7:10000), ภาวะรู้ตัวระหว่างให้ยาสลบ (3.8:10000) วินิจฉัยว่าใส่ท่อหายใจเข้าหลอดอาหารซ้ำ (4.1:10000) การใส่ท่อหายใจไม่สำเร็จ (3.1:10000) ภาวะอนาไฟแลกซิส หรือภาวะคล้ายอนาไฟแลกซิส (2.1:10000) บาดเจ็บของเส้นประสาท (2:10000) ภาวะสำลักน้ำ หรืออาหารเข้าปอด (2.7:10000) การให้ยาผิด (1.3:10000) บุคลากรวิสัญญีได้รับอันตราย (1.5:10000) เข้าพำนักในโรงพยาบาลโดยไม่ได้คาดการณ์ไว้ก่อน (1:10000) ภาวะการระงับความรู้สึกทั่วทั้งไขสันหลัง (1.3:10000) และการให้เลือดผิดหมู่ (0.18:10000)*

สรุป: *ภาวะแทรกซ้อนของระบบทางเดินหายใจเป็นภาวะแทรกซ้อนที่เกี่ยวข้องกับวิสัญญีโดยตรงที่พบบ่อย ภาวะหัวใจหยุดเต้น และการเสียชีวิตภายใน 24 ชั่วโมง มีอุบัติการณ์สูง ทำให้เห็นความจำเป็นในการวิเคราะห์หากลยุทธ์ในการป้องกัน ข้อมูลของภาวะแทรกซ้อนที่ได้จากการศึกษานี้มีประโยชน์ในการใช้เพื่อพัฒนาคุณภาพบริการ การประกันคุณภาพการศึกษา และการศึกษาวิจัยในขั้นตอนต่อไป เพื่อความปลอดภัยทางวิสัญญี*