The Thai Anesthesia Incident Monitoring Study (Thai AIMS) of Post Anesthetic Reintubation: An Analysis of 184 Incident Reports

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Objective: *The present study was a part of the Multi-centered Study of Model of Anesthesia related Adverse Events in Thailand by Incident Report (The Thai Anesthesia Incident Monitoring Study or Thai AIMS). The objective of the present study was to determine the outcomes, contributory factors and factor minimizing incident.*

Material and Method: *The present study was a descriptive research design. The authors extracted relevant data from the incident reports on reintubation after planned extubation after general anesthesia with endotracheal intubation from the Thai AIMS database during the study period January to June 2007. The cases were extensively reviewed by 3 reviewers for conclusion of anesthesia directly and indirectly related reintubation. Comparative analysis between two groups was done.*

Results: *A total 184 incidents of extubation failure according to the definition were extracted in which 129 cases (70.1%) were classified as directly related to anesthesia and 55 cases (29.9%) were indirectly related to anesthesia. Oxygen desaturation occurred in 85.9% of cases while 90.2% of patients was reintubated within 2 hours after extubation. Hypoventilation (58.1%) was the commonest cause which led to reintubation directly related to anesthesia while upper airway obstruction (39.6%) was the commonest cause in the indirectly related anesthesia group. The proportion of preventable incident was 99.2% and 54.5% in directly and indirectly related anesthesia groups, respectively. Human factors particularly including lack of experience and inappropriate decision-making were considered in 99.2%, are directly related to anesthesia reintubation group.*

Conclusion: *Extubation failure and reintubation was mostly related to anesthesia. Most of directly related to anesthesia group were considered as preventable. Human factors were also claimed as contributing factors. Quality assurance activity and improvement of supervision to improve experience and competency of decision making were suggested corrective strategies.*

Keywords: *Reintubation, Complication, Anesthesia, incident report, Extubation failure*

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Incidences of extubation failure after general anesthesia with endotracheal intubation or reintubation after planned extubation can vary from 2:10,000 to 35:10,000[1-5]. The authors' previous report demonstrated that most of them were related to anesthetic care and more than 80% were preventable[3]. Even though seventy-five percent of cases were fully recovered within 24 hours after reintubation, some of them suffered from aspiration, severe hypoxia, respiratory failure or needed surgical airway because of the unsuccessful reintubation[3].

The primary aim of the present study was to determine primary causes of post anesthetic extubation failure in Thailand.

Material and Method

During a period from January 2007 to June 2007, the Royal College of Anesthesiologists of Thailand conducted a prospective multi-centered study of incident report from 51 hospitals ranging from primary to tertiary hospitals across Thailand. The present study was approved by each institutional ethical committee. The methodology of the present study has already been described using the model of anesthesia related adverse events by incident report, The Thai Anesthesia Incident Monitoring Study, Thai AIMS[6]. The definition for reintubation in the present study was defined as the patient was intubated again within 24 hours after extubation at the end of anesthetic care.

Each case was reviewed by three reviewers to make consensus conclusion of main contributing of the extubation failure was indirectly or directly or related to anesthetic care. If the initial symptom was airway obstruction suddenly happening after extubation and the primary cause was unpredictable such as severe vocal cord edema, laryngospasm, bronchospasm or laryngeal nerve injury, the cases were grouped in "indirectly related to anesthesia". But if the cause of airway obstruction closely related to anesthesia such as the patient could not maintain airway or could not clear up secretion by themselves, the cases were grouped in "directly related to anesthesia".

Data analysis was performed by using SPSS for Windows, version 12. Data was presented in number and percentage. Comparisons between groups of indirectly related or directly related to anesthesia were analyzed by the Unpaired t-test for continous variables. Fisher exact A p-value of less than 0.05 was considered statistically significant Chi-square statistics or Fishesseact test of discrete variables.

Results

One hundred and eighty-four reports of reintubation according to the definition were extracted from 2537 incident reports in 1,996 patients. Ages were in the range from 8 days to 96 years and 88.6% of cases were older than 6 years. Extubation failure occurred commonly in males (54.3%), official time (66.3%), non-emergency procedures (57.1%) and ASA 2 and 3 (Table 1). Oxygen desaturation was the most common co-event and was found in 85.9% of patient with extubation failure. Reintubation was performed mostly (90.2%) within two hours after extubation. Decision to reintubation was mostly (83.2%) directed by clinical signs of patient distress and changing in stage of consciousness (Table 2). Hypoventilation (45.1%) was considered as the most common medical cause of extubation failure. The extubation failure could be avoided in 85.9% of cases by improving competency in decision-making of the care team. Reintubation led to prolonged emergence and major respiratory effects in 32.6% and 42.4% of cases, respiratory (Table 3). Seventy-five percent had complete recovery within 7 days; while 9.2% of reintubation cases died in 7 days. Eight percent needed prolonged ventilatory support, 4.4% suffered from major neurological deficit, 2.7% required prolonged hospital stay and 0.5% developed acute myocardial infarction due to the intubation process.

There were 129 cases (70.1%) grouped as "directly related to anesthesia" and 55 cases (29.9%) as "indirectly related to anesthesia". All demographic data and procedures situation which included the distribution of age, sex, height, body weight, anesthetic duration, emergency procedures, official time, distribution of ASA classification, occurrences of oxygen desaturation and types of procedures in both groups were not statistically different ($p > 0.05$) (Table 1).

Reintubation in most of directly related to anesthesia group happened in the operative theater (50.4%) and in the emergence period (74.4%) after anesthesia or immediately after extubation while the incident in the indirectly related to anesthesia group happened mostly in the recovery room and some in the ward and intensive care unit in the recovery period, ($p < 0.001$) (Table 2). Hypoventilation was the highest medical cause which led to reintubation in the directly related to anesthesia group while upper airway obstruction was the highest cause in the indirectly related to anesthesia group. Clinical signs were used as a main decision strategy to reintubation. Nearly all cases (99.2%) in directly related to anesthesia group were

Table 1. Demographic, surgical and anesthetic characteristion patients with reintubation

Variables		Total cases (n = 184)	Directly related to anesthesia related (n = 129)	Indirectly related to anesthesia (n = 55)	p-value
Age (yrs)	Range	0.08-96	0.08-96	0.1-82	
	$\bar{x} \pm$ SD	49.4 ± 24.8	49.7 ± 24.8	48.6 ± 25.1	
	< 1	11 (6)	8 (6.2)	3 (5.5)	0.76
	≥ 1-6	10 (5.4)	6 (4.7)	4 (7.3)	
	> 6	163 (88.6)	115 (89.1)	48 (87.2)	
Body weight (Kg)	Range	0.7-120	0.7-119	2.4-120	
	$\bar{x} \pm$ SD	52.8 ± 21.9	53.4 ± 20.6	51.4 ± 24.7	>0.05
Height (cm)	Range	47-182	50-175	47-182	
	$\bar{x} \pm$ SD	151.4 ± 27.9	153.2 ± 25.3	147.3 ± 32.8	>0.05
Anesthetic duration (min)	Range	15-425	15-425	30-315	
	$\bar{x} \pm$ SD	122.5 ± 80.4	123.5 ± 82.1	119.7 ± 76.8	>0.05
Sex	M : F	54.3:45.7	57.4:42.6	47.3:52.7	0.208
Emergency	No : Yes	57.1:42.9	60.5:39.5	49.1:50.9	0.154
Non-Office time	No : Yes	66.3:33.7	68.2:31.8	61.8:38.2	0.401
ASA	1	29 (15.8)	23 (15.8)	6 (10.9)	0.49
	2	69 (37.5)	50 (38.8)	19 (34.5)	
	3	75 (40.8)	49 (38.0)	26 (47.3)	
	4	11 (6)	7 (5.4)	4 (7.3)	
Other complication	No : Yes	14.1:85.9			
Desaturation	No : Yes	25.5:74.5	22.5:77.5	32.7:67.3	0145
Type of operation					>0.05
Cardiac		1 (0.5)	0	1 (1.9)	
General		62 (33.7)	46 (35.7)	16 (29.6)	
Orthopedic		28 (15.2)	23 (17.8)	5 (9.3)	
Otorhinolaryngological		18 (9.8)	9 (7)	9 (16.7)	
Plastic surgery		5 (2.7)	4 (3.1)	1 (1.9)	
C-spine		5 (2.7)	4 (3.1)	1 (1.9)	
Gynecological surgery		14 (7.6)	10 (7.8)	1 (1.9)	
Obstetrical surgery		2 (1.1)	1 (0.8)	1 (1.9)	
Endoscopic procedure		11 (6.5)	6 (4.7)	5 (9.3)	
Urological		13 (7.1)	9 (7)	4 (7.4)	
Neurosurgery		14 (7.6)	6 (4.7)	8 (14.8)	
Thoracic		3 (1.6)	1 (0.8)	2 (3.7)	
Opthalmological		13 (7.1)	11 (8.5)	2 (3.7)	
Dental		1 (0.5)	1 (0.8)	0	
Intervention procedure		4 (2.2)	2 (1.6)	2 (3.7)	
No data		3 (1.6)	1 (0.8)	2 (3.7)	

Value shown mean $\bar{x} \pm$ SD, number (percentage), ratio

concluded as "preventable" in which 29.5% of them were related to training process in anesthetic section and the risk ratio was 5.3, 95% CI of 1.8,15.8 (Table 2). Human factors were coded as a contributing factor of reintubation in both groups and were related to inappropriate decision making. The ratio of "Decision making" was higher in the directly related to anesthesia group, $p < 0.001$.

Both immediate and long term outcomes of reintubation in the "directly related to anesthesia group" were better than in the "indirectly related to anesthesia group" (Table 3). Most of the "directly related to anesthesia group" (39.5%) the successful re-extubation happened within 2 hours after reintubation and the other 43.4% needed ICU for less than 24 hours of ventilatory supported. But reintubation in the

Table 2. Time, places, diagnosis, cause and preventability of re-intubation

Variables	Total cases (n = 184)	Directly related to anesthesia related (n = 124)	Indirectly related to anesthesia (n = 55)	p-value
Sequence of anesthesia				
Emergence	115 (62.5)	96 (74.4)	19 (34.5)	0.000*
Recovery (2 hours)	51 (27.7)	31 (24.0)	20 (36.4)	
Post recovery (> 2 hours)	18 (9.8)	2 (1.6)	16 (29.1)	
Location of reintubation				
Operative theater	78 (42.4)	65 (50.4)	13 (23.6)	0.000*
Recovery room	74 (40.2)	52 (40.3)	22 (40.0)	
ICU	7 (3.8)	1 (0.8)	6 (10.9)	
Ordinary ward	25 (13.6)	11 (8.5)	14 (25.5)	
Main decision by				
Clinical sign	153 (83.2)	107 (82.9)	46 (83.6)	0.646
Desaturation	29 (15.8)	20 (15.5)	9 (16.4)	
EKG	2 (1.1)	2 (1.6)	0	
Capnograph	0	0		
Main medical cause				
Hypoventilation	83 (45.1)	75 (58.1)	8 (15.1)	0.000*
Airway obstruction	43 (23.4)	22 (17.1)	21 (39.6)	
Respiratory failure	23 (12.5)	16 (12.4)	7 (13.2)	
Unstable hemodynamic	14 (7.6)	6 (4.7)	8 (15.1)	
Change in stage of conscious	19 (10.3)	10 (7.8)	9 (17.0)	
Preventability (yes)	158 (85.9)	128 (99.2)	30 (54.5)	0.000* (OR 109.2, 13.9-818)
Related to training (yes)	42 (22.8)	38 (29.5)	4 (7.3)	0.001* (OR 5.3, 1.8-15.8)
Related to Human factors	152 (82.6)	128 (99.2)	25 (45.5)	0.000*
Human factor due with				
Experiences	41 (26.9)	29 (22.5)	12 (48)	0.000*
Decision making	110 (72.4)	98 (76.6)	12 (48)	0.000*
Ignorance	2 (0.7)	1 (0.9)	1 (4)	

* Statistically significant by p value < 0.05
Value shown as number (percentage)
OR = odd ratio with 95% confidence interval

"directly related to anesthesia group" caused 2 cases (1.6%) of major neurological deficit, 5 cases (4.7%) of major hemodynamic impairment which were not included in 2 cases of cardiac arrest and the other 3 cases of sudden death after reintubation. These 12 cases in the "directly related to anesthesia group" were classified as preventable events. About eighty two percent in the "directly related to anesthesia group" completely recovered which was better than 58.2% in "indirectly related to anesthesia group". Human factors regarding "wrong decisions" (36.4%) and "hurried" (27.1%) were significantly higher in "directly-related to anesthesia group" ($p < 0.001$), while "inadequate experience" was equally involved in both groups. The proportion of extubation failure that could be minimized by "vigilance" was significantly higher in the "directly related to anesthesia group" than in the "indirectly related to anesthesia group" (41.1% versus 25.6%, $p < 0.001$). Strategies to minimized extubation failure during post operative period in both groups were "Quality assurance" process together with improved supervision and communication.

Discussion

Extubation failure or reintubation after planned extubation in postoperative period could be attributed by multiple factors which included anesthetic care, surgical cause or complication of surgery, patients and

Table 3. Immediate and long term outcome, contributing factors, factor minimized by and suggested strategies divided by related or not related to anesthesia data were displayed percentage

Variables	Total cases (n = 184)	Directly related to anesthesia related (n = 124)	Indirectly related to anesthesia (n = 55)	p-value
Immediate outcome				
Unplanned ICU	5.4	6.2	3.6	0.000*
Prolonged emergence	32.6	39.5	16.4	
Major respiratory effect	42.4	43.4	40.0	
Major CVS	7.1	4.7	12.7	
Major neurological effect	6.5	1.6	18.2	
Cardiac arrest	2.2	1.6	3.6	
Death	2.2	2.3	1.8	
Complete recovery	1.1	0.8	1.8	
Minor change	0.5	0	1.8	
Long term outcome				
Prolonged ventilatory support	8.2	8.5	7.3	0.003*
Prolonged hospital stay	2.7	1.6	5.5	
Major neurological effect	4.4	2.4	9.1	
Death	9.2	4.7	20.0	
Complete recovery	75.0	82.2	58.2	
Myocardial infarction	0.5	0.8	0	
Contributing factor				
Wrong decision	33.3	36.4	25.0	0.000*
Lack of knowledge	2.3	2.3	2.1	
Inadequate experience	34.5	34.1	35.4	
Hurry	21.5	27.1	6.3	
Not enough personnel	0.6	0	2.1	
Emergency situation	4.0	0	14.6	
Surgical induce	4.0	0	14.6	
Factor minimized				
More experience	23.8	26.3	16.3	0.000*
Help by experienced person	18.0	17.8	18.6	
More carefull	37.2	41.1	25.6	
More personnel	1.2	0.8	2.3	
Improve counseling	4.1	3.1	7.0	
Improve communication	7.0	3.1	18.6	
Improved training	5.8	7.8	0	
More monitor	2.9	0	11.6	
Suggested strategies				
Guideline practice	7.3	5.5	12.0	0.001*
Additional training	3.4	3.9	2.0	
Improved supervision	28.1	33.6	14.0	
Improved communication	5.1	1.6	14.0	
QA	54.3	55.5	58.0	

* Statistically significant at p-value < 0.05
Value shown as percentage

medical care system. Pre-operative critically ill patients or patients with multiple organ failure, septic shock or ASA class 4-5 scheduled for major procedure were not suitable for immediate extubation after anesthesia and surgery. And high dependency or intensive care unit should be available. There was unreasonable acceptance for decision to extubate because of the shortage of high medical support system. This should

be one of hospital policy to improve quality of medical care. This case series demonstrated that at least four cases, the extubation were pressured by limitation of postoperative intensive medical care (Table 1, four cases of ASA 4 were indirectly related to anesthesia group).

The authors' cases series demonstrated that seventy percent of extubation failure was directly related to anesthesia; symptom of inadequate ventilation with agitation, severe restlessness and conscious change with oxygen desaturation happened shortly after extubation and most of the cases that directly related to anesthesia were reintubated in operative theater or recovery room within two hours after extubation. Not to the authors surprise, extubation failure directly related to anesthesia were more preventable, closely related to "decision-making" with better short and long-term outcomes both clinically and statistically significant than those indirectly related to the anesthesia group. In the directly related to anesthesia group, hypoxia and hypoventilation could be treated easily by reintubation and short-period of ventilator-support (Table 3). This pattern of patient management and the result of very good outcome explained that the first extubation was done "too early" or before the patients had adequately recovered from either muscle relaxants or anesthetic agents or both. They could not maintain enough alveolar ventilation. Human factor was the highest related in directly-related (EDITOR'S NOTRE-this segment of the sentence needs review, it does not make sense and it is difficult to understand what the author wishes to express, Thank you. RWPons) to anesthesia groups in which the problem of "decision-making" was the commonest contributing factor, followed by "too hurried". Both these factors could bave been minimized by a regular feedback process with community target goals or quality assurance. Continuous reduction incident of reintubation could be set as a hospital target control in an anesthetic quality system.

From the authors' analysis, the percentage of reintuation relating to inadequate training supervision was higher in the directly related anesthesia group than in the indirectly-related anesthesia group (Table 2). This could indicate that close supervision by instructors should be conducted especially at the end of anesthesia and the time of extubation for each trainee until each of them has decision-making competency for extubation.

From the authors' previous THAI Study, the incidence of extubation failure in postoperative period was 0.27% or 27:10000[3] and was much lower than extubation failure in medical and pediatric intensive care units which varied from 5 to 10%[7-10]. But the total number of endotracheal tube that were extubated at the end of anesthetic care was much higher than in the intensive care unit[1-10]. The total number of patients who suffered from extubation failure in the post-operative period was higher than in the intensive care setting. Even the outcome of extubation failure related to anesthesia was better than in intensive care patient[2,7]. But the process of reintubation could be more difficult and could lead to severe deficit or even death (Table 3).

In adult patients who were intubated and mechanical ventilatory supported for more than 48 hours, the guidelines suggest that the patients should be put on spontaneous breathing trial for at least 2 hours, all respiratory parameters should be repeated to confirm adequate ventilation[11-13]. Even after successful spontaneous breathing trial, the risk of extubation failure was still higher in rapid, shallow breathing index (> 57 breaths/L/min), positive fluid balance and pneumonia patient[10]. It has been suggested that, after extubation, early non-invasive ventilation should be used to prevent extubation failure[9]. Can the authors apply these findings in an anesthetic setting? The authors suggest that at the end of anesthesia, after muscle relaxant was reversed, respiratory support should be stepwise reduction from full control to partial support and spontaneous breathing in consequence. Sufficient time is needed to confirm adequate ventilation especially in patients who are not fully awake. Extubation is recommended when the patient is fully awake, responds to verbal commands and has muscle strength enough to maintain both spontaneous breathing without endotracheal tube and upper airway support. If extubation has to be performed in a non-alert patient, supportive ventilation via anesthetic face mask should be used to maintain upper airway and increased alveolar ventilation until adequate respiration is confirmed.

Conclusion

Extubation failure and reintubation was mostly related to anesthesia. Most of directly-related-to-anesthesia group was considered as preventable. Human factors were also claimed as contributing factors. Quality assurance activity and improvement of supervision to upgrade experience and competency of decision-making were suggested corrective strategies.

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อุบัติการณ์การใส่ท่อหายใจใหม่ภายหลังการถอดท่อหายใจ เมื่อเสร็จสิ้นการให้ยาระงับความรู้สึกในประเทศไทย

ฐิติมา ชินะโชติ, สุจารีย์ ภู่พิพัฒน์ภาพ, สุภาภรณ์ บูรณตรีเวทย์, กนก ธราธารกุลวัฒนา, เทวารักษ์ วีระวัฒกานนท์, ประสาทนีย์ จันทร

วัตถุประสงค์: *การศึกษานี้เป็นส่วนหนึ่งของการศึกษาแบบสหสถาบัน ของแบบจำลองการเกิดภาวะแทรกซ้อนทางวิสัญญีในประเทศไทยโดยการรายงานอุบัติการณ์ (The Thai Anesthesia Incident Monitoring Study) โดยการศึกษานี้เน้นเฉพาะรายงานที่เกี่ยวข้องกับการใส่ท่อหายใจใหม่ ภายหลังการถอดท่อหายใจ เมื่อเสร็จสิ้นการให้ยาระงับความรู้สึก วัตถุประสงค์ของการศึกษานี้ เพื่อหาผลที่เกิด ปัจจัยนำ และปัจจัยลดอุบัติการณ์*

วัสดุและวิธีการ: *เป็นการศึกษาเชิงคุณภาพจากการวิเคราะห์ข้อมูลที่ได้จากการศึกษาแบบสหสถาบันของแบบจำลองการเกิดภาวะแทรกซ้อนทางวิสัญญีในประเทศไทยโดยการรายงานอุบัติการณ์ ระหว่างเดือนมกราคม ถึง เดือนมิถุนายน พ.ศ. 2550 แบ่งเป็นสองกลุ่ม กลุ่มที่มีความสัมพันธ์หรือไม่มีความสัมพันธ์กับกระบวนการให้ยาระงับความรู้สึก วิเคราะห์ความแตกต่างระหว่างทั้งสองกลุ่ม*

ผลการศึกษา: *จากการทบทวนพบรายงานอุบัติการณ์ 184 รายของผู้ป่วยที่ได้รับการใส่ท่อหายใจใหม่หลังการผ่าตัดตามคำจำกัดความโดย 129 ราย (ร้อยละ 70.1) ได้รับการจัดเป็นกลุ่มที่เกี่ยวข้องกับวิสัญญีโดยตรง และ 55 ราย (ร้อยละ 29.9) เป็นกลุ่มที่เกี่ยวข้องกับวิสัญญีโดยอ้อม พบภาวะอัตราความอิ่มตัวของออกซิเจนต่ำร้อยละ 85.9 และร้อยละ 90.2 ของผู้ป่วยได้รับการใส่ท่อหายใจภายใน 2 ชั่วโมงหลังการถอดท่อหายใจ ภาวะการหายใจไม่เพียงพอ (ร้อยละ 58.1) เป็นสาเหตุที่พบบ่อยที่สุดในกลุ่มที่เกี่ยวข้องกับวิสัญญีโดยตรง ในขณะที่การอุดกั้นทางเดินหายใจส่วนบน (ร้อยละ 39.6) เป็นสาเหตุที่พบบ่อยที่สุดในกลุ่มที่เกี่ยวข้องกับวิสัญญีโดยอ้อม ร้อยละ 99.2 และร้อยละ 54.5 ของกลุ่มที่เกี่ยวข้องกับวิสัญญีโดยตรงและโดยอ้อมตามลำดับ ร้อยละ 99.2 ของกลุ่มที่เกี่ยวข้องกับวิสัญญีโดยตรงเกี่ยวข้องกับความผิดพลาดของมนุษย์ซึ่งได้แก่ การขาดประสบการณ์ และการตัดสินใจไม่เหมาะสม*

สรุป: *การใส่ท่อหายใจใหม่ส่วนใหญ่เกี่ยวข้องกับวิสัญญีเกือบทั้งหมดของภาวะที่ต้องใส่ท่อหายใจใหม่ในกลุ่มที่เกี่ยวกับวิสัญญีโดยตรงสามารถป้องกันได้ ซึ่งมักเกี่ยวข้องกับปัจจัยความผิดพลาดของมนุษย์ การฝึกอบรม กลยุทธ์ที่แนะนำได้แก่ กิจกรรมพัฒนาคุณภาพ และการปรับปรุงการให้คำปรึกษา*