Unplanned Intubation during Anesthesia: Review of 31 Cases from The Thai Anesthesia Incidents Study (THAI Study)

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Objectives: *To examine the causes, outcomes, and contributing factors associated with patients requiring unplanned emergency intubation for adverse respiratory events.*
Meterial and Method: *Appropriate unplanned intubation incidents were extracted from the Thai Anesthesia Incidents Study (THAI Study) database conducted between February 1, 2003, and January 31, 2004, and analyzed using descriptive statistics.*
Results: *Thirty-one incidents of unplanned intubation were recorded, 21 of which were due to respiratory problems particularly after bronchoscopy with and without surgery of the upper airway. Six of the 21 cases (28.6%) were children under 10 years of age who suffered from papilloma of the larynx. Sixteen cases of the 31 cases (52%) of the unplanned intubations were due to inadequate ventilation; 13 cases (41%) due to laryngeal edema; 11 cases (36%) due to sedative agents. The other events were the result of unstable hemodynamics, severe metabolic acidosis, muscle relaxants, and intrapulmonary lesions. Eighteen cases of unplanned intubations (18/31) (58%) occurred in the Post-Anesthesia Care Unit, 5 cases (16%) in a ward, and 4 (13%) in the operating room. The reported contributing factors included inadequate experience, lack of supervision and the patient's condition.*
Conclusion: *Major incidents of unplanned intubation occurred after bronchoscopy. Common contributing factors related to inadequate ventilation, airway obstruction, sedative agents and unstable hemodynamics. Quality assurance, additional training, and improved supervision tended to minimize the incidents.*

Keywords: *Anesthesia, Intubation, Risk factors, Unplanned, Complications*

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Anesthesiologists have an outstanding record in patient safety and adopting improvements, however, both preventable and unforeseeable adverse respiratory events persist[1]. Peri-operative complications occur in 18 to 30 percent of anesthetic cases[2]; moreover, emergency airway management can be fraught with complications related to hemodynamic alteration and difficulty with oxygenation and ventilation[3]. Thus, major complications occur frequently during emergency tracheal intubation outside the operating room[4,5].

The relationship between anesthesia and a patient's surgical-related risk factors for unplanned intubation remains inconclusive; the authors therefore examined the association between pre-operative patient-characteristics, surgical factors, anesthetic management and the incidence of unplanned intubation in Thailand.

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Material and Method

The Thai Anesthesia Incidents Study (THAI Study) is a multi-centered study including seven

university hospitals, five tertiary care hospitals, four secondary care hospitals, and four district hospitals[6,7]. The authors monitored the incidence of adverse events between February 1, 2003, and January 31, 2004. Unplanned intubation was defined as an unexpected endotracheal intubation performed with anesthetic technique such as after direct laryngoscopy with a bronchoscope, monitored anesthetic care, or a regional block.

The THAI Study was approved by the Institutional Ethicals Review Board, which deemed that written consent was not required for the survey. Details of pre-anesthetic conditions, anesthetic management, intra-operative events and peri-operative complications among consecutive patients within 24 hours of surgery were recorded on a standardized form. A subset of patients, who experienced unplanned extubation, re-intubation, and unplanned emergency intubation, was reviewed.

During the 12-month study, all patients requiring tracheal intubation after anesthesia, for clinical deterioration from cardiac, pulmonary, trauma, septic or neurologic insults, were enrolled and surveyed as part of the Department's quality improvement program (QA). Each case was reviewed by the preliminary QA committee, comprising three anesthesiologists from different university hospitals, to assess whether the inclusion criteria were met.

Contact was made with the anesthesiologist involved or the admitting hospital's anesthetic records reviewed. The QA committee participated in the peer review of the reported cases in order to reach a consensus of the type of error. The assumption underlying the authors' QA peer review process was that all adverse outcomes of unplanned intubation were the result of either 'human' or 'system' error.

Each incident form was reviewed and relevant factors entered into the SPSS program. Data were entered as originally recorded on the individual reports then analyzed. The demographic data included age, sex, ASA status and co-morbidities. The authors recorded the type of event, the indications for unplanned emergency intubation, the type(s) of anesthetic used, and both the immediate and longer-term outcomes.

Risks were categorized into patient, anesthetic, surgical and systemic factors. The patient-risk factors included pathology of each patient's disease, symptoms and signs before intubation. The anesthetic risk factors included anesthetic drugs and technique(s). The surgical risk factors included the type and site of surgery, emergency situation and duration of surgery. The systematic risk factors included the level of hospital, occurrence place and contributing factors.

Data collection and analysis

The data from each hospital were keyed in at the data management center using a double entry technique to ensure the reliability of data entry. All statistical analyses were performed with SPSS version 11.5 (SPSS Inc, Chicago, IL). Descriptive statistics were used to calculate the occurrence of anesthesia-related adverse outcomes.

Results

Demographics data and clinical details

Thirty-one (17 men; 14 women) consecutive unplanned intubations from 163, 403 enrolled patients were performed. Age ranged between 3 months and 83 years (average, 43.6 ± 28.6). The greatest incidence (38.8%) occurred in patients ≥ 60 years of age. The averaged BMI was 21.1 ± 5.6 kg/m^2. The majority of patients had an ASA physical status of II (48.4%) or III (29.0%). Most of the cases (74.2%) were treated at a university or tertiary (25.8%) hospital (Table 1).

Indication(s) for intubation

The primary diagnoses at the time of tracheal intubation are presented in Table 2. The signs and symptoms indicating a tracheal intubation included respiratory condition (87.1%), desaturation (71.0%), upper airway obstruction (48.4%) neurology (35.5%), and cardiovascular conditions (*i.e.* sepsis and cardiac arrest - 6.2%).

Patient and surgical factors

Older patients (> 60 years) and men were at increased risk of critical respiratory events (Table 1). The most common co-morbidities were hypertension (25.6%), diabetes (16%), chronic obstructive pulmonary disease (12.8%), and lower leg infection (12.8%).

The surgical site might be considered a factor in the development of a laryngeal injury. Among the 21 of 31 patients undergoing unplanned intubation, the surgical sites included bronchoscopy (n = 12), microscopic direct laryngoscopy (n = 4), other endoscopy (n = 3), and surgery of head and neck (n = 2) (Table 3):

1) Six (28.6%) were children under 10 who suffered from papilloma of the larynx;

2) Five suffered cardiac arrest - with and without high block after spinal block - and two died within three days of surgery, as resuscitation was unsuccessful;

Table 1. Demographic data of unplanned intubation compared with re-intubation group

		Re-intubation	Unplanned intubation
Total cases		308	31
Ratio: 10 000		35.5	1.94
Sex (male/female)		178/130	17/14
Age (Yr):	mean ± SD	43.3 ± 28.1	43.6 ± 28.6
Age range (Yr): N (%)	< 1	31(10.1)	1 (3.2)
	1-10	35 (11.4)	5 (16.1)
	11-30	38 (12.3)	5 (16.1)
	31-50	58 (18.8)	6 (19.4)
	51-70	88 (28.6)	8 (25.8)
	> 70	58 (18.8)	6 (19.4)
Body weight:	mean ± SD	46.7 ± 22.7	46.5 ± 22.0
	Range	1.6-100	3.5-90
Height (cm):	mean ± SD	142.2 ± 36.7	143.1 ± 27.6
	Range	40-180	80-175
Operation time:	mean ± SD	135.0 ± 95.4	59.0 ± 31.9
ASA: N (%)	Class 1	41 (13.3)	5 (16.1)
	Class 2	152 (49.4)	15 (48.4)
	Class 3	104 (33.8)	9 (29.0)
	Class 4	11 (3.6)	2 (6.5)
Emergency case: (%)		32.5	35.5
Level of hospital: N (%)			
	University hospital	187 (60.7)	23 (74.2)
	Tertiary care	103 (33.5)	8 (25.8)
	Secondary care	18 (5.8)	0
Place at: N (%)			
	Operating Room	96 (31.2)	4 (12.9)
	PACU	118 (38.3)	18 (58.1)
	Ward	56 (18.2)	5 (16.1)
	ICU	37 (12.0)	4 (12.9)
	Other	1 (0.3)	-

Table 2. Primary indications at time of unplanned intubation (N = 31)

Signs and Symptoms	Number of Patient (%)
Dyspnea	27 (87.1)
Desaturation	22 (71.0)
Upper airway obstruction	15 (48.4)
Conscious change	11 (35.5)
Hypotension	5 (16.1)

3) Two developed dyspnea after brachial block - one from pneumothorax and the other in the throes of severe sepsis; and,

4) Five underwent intubations to support ventilation to correct for hypoventilation or upper airway obstruction because of total intravenous anesthesia.

Table 4 summarizes the causes of unplanned intubation including: inadequate ventilation (51.6%), laryngeal edema 13 (41.9%), sedative agent (35.5%), and unstable ischemic heart disease (29%).

Timing of unplanned intubation

The most common time for unplanned intubation was within 1-3 hours after surgery (54.9%), immediately after extubation (19.4%), between 3 and 12 hours after surgery (19.3%), and during the intraoperative period (6.5%) (Table 1).

Unplanned emergency intubations were preventable in 13 patients (41.9%), partially preventable in 14 (45.2%), and not preventable in 3 (9.7%). Anesthesia was considered the sole contributing factor in 5 patients (16.1%) and a combination of other factors in 20 (64.5%).

Table 3. Operative procedure before unplanned intubation (N = 31)

Surgical procedure	N (%)
Bronchoscope	12 (38.7)
Microscopic direct laryngoscope	4 (12.9)
Other endoscope	3 (9.7)
Surgery of larynx	1 (3.2)
Thyroid	1 (3.2)
Upper abdomen	1 (3.2)
Lower abdomen	1 (3.2)
Extremities	6 (19.4)
Other superficial	1 (3.2)
Cardiac catheterization	1 (3.2)

Table 4. Causes of unplanned intubation

Causes	N (%)
Muscle relaxant	3 (9.7)
Sedative agent	11 (35.5)
Severe metabolic acidosis	5 (16.1)
Unstable hemodynamic	9 (29.0)
Endotracheal tube problem	1 (3.2)
Upper airway obstruction	
Laryngeal edema	13 (41.9)
Secretion	2 (6.5)
Laryngospasm	1 (3.2)
Ventilation	
Inadequate ventilation	16 (51.6)
Hypoxia	3 (9.7)
Apnea	1 (3.2)
Intrapulmonary lesion	
Atelectasis	1 (3.2)
Pulmonary edema	2 (6.4)
Pulmonary congestion	1 (3.2)
Pulmonary infection	1 (3.2)

The outcome managements after unplanned emergency intubations are summarized in Table 5. The immediate outcomes included major transient physiologic changes (58.1%) and death (6.9%). Most (61.3%) transient symptoms completely resolved in the long-term; prolonged respiratory support was required for 22.6%.

An analysis of the system indicated that the three most important contributing factors were: lack of supervision (22, 71%), inexperience (20, 64.5%), and inappropriate decisions (16, 51.6%) (Table 6). The majority of case reports included proposed corrective strategies such as QA activities after the events (26, 83.9%), improved supervision (23, 74.2%) and additional training (19, 61.3%) (Table 7).

Table 5. Outcome of management

1. Immediate outcome (within 24 hr)	N (%)
Complete recovery	3 (9.7)
Minus transient physiologic change	6 (19.4)
Major transient physiologic change	18 (58.1)
Cardiac arrest	1 (3.2)
Death	2 (6.9)
2. Long term outcome (> 24 hr to 7 days post-operative)	
Complete recovery	19 (61.3)
Prolonged respiratory support	7 (22.6)
Death	2 (6.5)
Unplanned ICU admission	1 (3.2)
Vegetative/ Brain death	1 (3.2)

Table 6. Contributing factors (N = 31)

Factors	N (%)
Human factors	
Inadequate decision	16 (51.6)
Inadequate knowledge	8 (25.8)
Inexperience	20 (64.5)
Hasty	7 (22.6)
Inadequate care	
Inadequate pre-operative	14 (48.3)
Lack of supervision	22 (71.0)
Communication failure	12 (38.5)
Medical failure	10 (32.3)
Facility failure	
Recovery room care failure	-
Intensive care unit care failure	1 (3.2)
Patient condition	11 (35.5)
Organization factor	5 (16.1)

Table 7. Suggestive corrective strategies

Strategies	N (%)
Quality assurance	26 (83.9)
Improve supervision	23 (74.2)
Additional training	19 (61.3)
Care improvement	17 (54.8)
Improve communication	12 (38.7)
Guideline practice	10 (32.3)
More manpower	5 (16.1)
Good referral system	1 (3.2)

Discussion

To the authors' knowledge, this is the first large-scale database review investigating the reasons for unplanned intubations among re-intubated cases during the intra-operative and post-anesthesia period. Detailed analyses of intra-operative mishaps show that respiratory-based complications during airway management, *i.e.,* oxygenation and ventilation difficulties, account for nearly one-third of all anesthetic deaths[1,8,9].

Awareness of co-existing morbidities is important because some diseases can potentiate neuromuscular-blocking drug action. Elderly, obese and patients with either renal or hepatobiliary disease may have altered pharmacodynamic responses to muscle relaxants. Other anesthetic interactions include inhaled drugs, sedatives, and ambient temperature. The present study did not review specific factors that may affect the duration of muscle relaxants[5,10]; thus the cause of muscle relaxant problems causing unplanned intubation in the peri-operative period may have been underreported.

The 58.1% frequency of unplanned intubation in the PACU is comparable to a report from Rose et al (1994)[11]. In a prospective review, Schwartz et at[4] found that emergency intubations mainly occurred outside the operating room and emergency department. Mortality associated with unplanned emergency intubation in the present study was highest among patients who were hemodynamically unstable or those receiving vasopressor therapy before intubation.

In the present study, the relevant risk factors attributed to unplanned intubation included: 1) the anesthetic drug(s) - especially sedatives (35.5%) and muscle relaxants (9.7%); 2) severe metabolic acidosis (16.1%); 3) unstable hemodynamics (29%); 4) upper airway obstruction as a result of laryngeal edema (41.9%); 5) inadequate ventilation (51.6%); 6) intrapulmonary pathology such as pulmonary edema (6.4%); and, 7) atelectasis (3.2%). This ranking is similar to a previous study in which respiratory complications were the most commonly observed causes of re-intubation in the peri-operative period[5].

Unintentional but unavoidable bruising and scratching of the airway during intubation, while under general anesthesia, is a source of morbidity for patients; thus anesthesiologists must continually perfect their technique in order to minimize its occurrence. The most frequent sites of injury are the larynx (33%) and pharynx (19%)[12].

Importantly, laryngeal edema, causing airway obstruction after extubation, associated with major neck surgery (*e.g.* thyroid, cervical spine, and carotid artery procedures), is potentially life-threatening (Table 3, 4). Identifying laryngeal edema before extubation would facilitate timely treatment and more cautious extubation[13-15]. In the present study, as others, the most common cause of airway obstruction was laryngeal edema (41.9%) and neither topical or systemic steroids ameliorated the condition[16,17]. In previous reports patients intubated for less than 24 hours were most likely to present with laryngeal injuries[16-18], but there is no evidence to confirm that laryngeal injuries are the result of serial attempts during bronchoscopy or direct laryngoscope microscopy.

The present results are consistent with reports that human error contributes to the majority of all system failures[19]. Lagasse et at reported that 92.2% were from system errors vs 7.8% from human error[20]. Knowledge-based (judgment) and rule-based (inadequate patient evaluation and preparation) errors were the most common contributing factors identified in the present study. Knowledge-based errors might be reduced by quality assurance activity and continuing medical education to improve supervision, while rule-based errors might be addressed by developing more practical guidelines. In the present study, the majority of incidents occurred in university hospitals where trainees in various disciplines are numerous; therefore, more supervisors, experience and skill improvement are the key means to reduce the risk of unplanned intubation.

The presented prospective review of 31 incidents indicated that unplanned emergency intubation, although infrequent, is associated with major morbidity and mortality, particularly among hemodynamically unstable patients with an ASA physical status of III or IV. Important risk factors included: a surgical procedure of the upper airway and neck, anesthetic drugs and underlying diseases. Factors that would minimize incidence include post-event QA assessment, improved supervision and additional training.

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สภาวะใส่ท่อช่วยหายใจซ้ำโดยไม่ได้คาดการณ์ล่วงหน้า

วราภรณ์ เชื้ออินทร์, ฐิติมา ชินะโชติ, ยอดยิ่ง ปัญจสวัสดิ์วงศ์, ศิริลักษณ์ กล้าณรงค์, กนก ธราธารกุลวัฒนา

วัตถุประสงค์: *เพื่อหาสาเหตุ ประเมินผลที่เกิด และปัจจัยที่เกี่ยวข้องกับอุบัติการณ์การใส่ท่อช่วยหายใจ โดยไม่ได้วางแผนมาก่อนหลังการให้ยาระงับความรู้สึก*

วัสดุและวิธีการ: *ศึกษาข้อมูลผู้ป่วยที่ได้รับการใส่ท่อช่วยหายใจโดยไม่ได้วางแผนมาก่อนหลังการให้ยาระงับความรู้สึกซึ่งคัดเลือกมาจากข้อมูลการศึกษาของราชวิทยาลัยวิสัญญีแพทย์แห่งประเทศไทยซึ่งรวบรวมตั้งแต่กุมภาพันธ์ พ.ศ. 2546 ถึง มกราคม พ.ศ. 2547 นำมาวิเคราะห์ทางสถิติเชิงพรรณนา*

ผลการศึกษา: *ผู้ป่วยที่เข้าเกณฑ์ 31 ราย มีผู้ป่วย 21 รายเกิดจากปัญหาทางเดินหายใจอุดกั้นตามหลังการทำหัตถการส่องกล้องทางเดินหายใจส่วนต้น ในจำนวนนี้ 6 รายเป็นผู้ป่วยเด็กอายุต่ำกว่า 10 ขวบ จากผู้ป่วยทั้งหมดพบว่ามีสาเหตุเกิดจากการหายใจไม่พอเพียง (ร้อยละ52) กล่องเสียงบวม (ร้อยละ41) และจากผลของยาสงบประสาท (ร้อยละ36) นอกจากนั้นมีสาเหตุจาก ระบบไหลเวียนโลหิตไม่คงที่ เกิดภาวะไม่สมดุลของกรดด่างรุนแรง ยาหย่อนกล้ามเนื้อ และปัญหาจากพยาธิสภาพของปอด ส่วนสถานที่เกิดเหตุพบมากที่สุดในห้องพักฟื้น (ร้อยละ58) รองลงมาคือที่ตึกผู้ป่วยและในห้องผ่าตัดคิดเป็นร้อยละ 16 และ 13 ตามลำดับ ส่วนปัจจัยเกื้อหนุนให้เกิดได้แก่ ไม่มีประสบการณ์ขาดคำชี้แนะ และปัญหาจากผู้ป่วยเอง*

สรุป: *การใส่ท่อช่วยหายใจโดยไม่ได้วางแผนมาก่อนหลังการให้ยาระงับความรู้สึกส่วนใหญ่เกิดภายหลังการทำหัตถการส่องกล้องทางเดินหายใจส่วนต้น ปัจจัยเกี่ยวข้องที่พบบ่อย ได้แก่ การหายใจไม่พอเพียง กล่องเสียงบวม และผลของยาสงบประสาท ระบบประกันสุขภาพงานบริการ การฝึกอบรมเพิ่มเติม และการให้คำชี้แนะน่าจะช่วยลดอุบัติการณ์ได้*