Outcomes and Risk Factors of Extubation Failure: A Multicenter Study of the THAI Surgical Intensive Care Units (SICUs)

Phakapan Buppha MD*[1], Chaiyapruk Kusumaphanyo MD*[1],
Kaweesak Chittawatanarat MD, PhD*[2], the THAI-SICU study group

*[1] *Department of Anesthesiology, Faculty of Medicine, Srinakharinwirot University, Nakhon Nayok, Thailand*
*[2] *Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Objective: *To identify risk factors associated with extubation failure (EF) in patients admitted to surgical ICUs (SICUs).*
Material and Method: *Data were gathered during April 2011-January 2013 by collecting demographic, admission details, daily summary, nutritional profile, APACHE II scores, and discharge summary from patients admitted to SICUs among nine university hospitals. Exclusion criteria include pediatric patients, non-consent patients, multiple trauma, cardiovascular and thoracic, and neurosurgical patients. Data were collected to the endpoint of 28 days of admission. Morbidity and mortality were determined. Complications or adverse events that occurred during admission were detailed in separate record forms.*
Result: *Of 4,652 patients, 2,890 were intubated. Among them, 2,749 were successfully extubated leaving 141 with extubation failure. Overall incidence of EF was 4.88% (with range from 1.41-7.33). Patient characteristics in EF groups were compared to successful groups. Advanced age, presence of congestive heart failure, vascular disease, COPD, emergency surgery, poor APACHE II and SOFA scores, and concurrent use of vasopressors, inotropes and sedatives were significant differences. The most common causes of EF were respiratory failure, inability to cough and laryngeal edema. Outcomes of EF included prolonged length of ICU stay [2 (IQR 1-5) vs. 11 (IQR 6-15) days] and hospital stay [16 (IQR 10-27) vs. 23 (IQR 15-33) days]. Patients with EF were at risk of 6-fold longer ICU stay than successful extubation. Adjusted odds ratio of age, congestive heart failure, emergency surgery, and SOFA score were identified with statistical significance to be risk factors of EF.*
Conclusion: *EF can affect outcomes of ICU admission. Identifying the risk factors associated with EF will help reduce its incidence and improve ICU outcomes.*

Keywords: *Extubation failure, Reintubation, Risk, Surgical ICU*

J Med Assoc Thai 2016; 99 (Suppl. 6): S136-S144
Full text. e-Journal: *http://www.jmatonline.com*

Extubation failure (EF) is one of the common events in the intensive care unit (ICU). The incidence of EF can be as high as 17%. Most articles define EF as re-intubation within 72 hours after planned extubation while some studies narrowed down to 24 hours[(1)]. Causes of EF are of great importance because consequences of EF vary from longer ICU stays to death. Identification of risk factors of EF was reported in many articles. Initiatives and preventive measures have been developed and aimed to reduce such consequences by implementing weaning/extubation protocol[(2)]. The present study aims to identify risk factors associated with EF in surgical patients admitted to 9 surgical ICUs (SICUs) in the university hospitals and the outcomes following EF.

Material and Method

After Institutional Review Board approval from each hospital patients age 15 years or older, who were admitted to surgical ICUs in nine Thai university hospitals during April 2011 to January 2013 were enrolled. Written informed consent was obtained by the patient or legal surrogate. Exclusion criteria included neurosurgical, multiple trauma, cardiovascular and thoracic, pediatric and non-consent patients. Data collected included demographic, admission details, daily summary, nutritional, APACHE II score and discharge summary. Adverse events and/or perioperative complications were also recorded in

Correspondence to:
Kusumaphanyo C, Department of Anesthesiology, Faculty of Medicine, Srinakharinwirot University, Nakhon Nayok 26120, Thailand.
Phone: +66-37-395085, Fax: +66-37-395275
E-mail: chaiyapruk@gmail.com

separate data sheets. In the present study when re-intubation within 72 hours after planned extubation or EF occurred, another case record form (CRF) 're-intubation' was filled with detailed information about re-intubation. All data were pooled to the THAI-SICU study group database. Methodology of the data collection was described elsewhere(3). Data regarding re-intubation were then retrieved from the database for analysis. Immediate outcomes of EF included hypoxemia, hypoxic encephalopathy, cardiac arrest, death, and the need of surgical airway. Long-term outcomes included length of ICU stay, length of hospital stay, ICU mortality and 28-day mortality. The possible confounders and imbalance of baseline characteristic variables were integrated in the multiple regression models.

Statistics used to analyze the data were done by STATA, version 11.0 (STATA Inc., College Station, TX). Descriptive data were reported as percentage of incidence. Characteristics of patients between groups were analyzed using t-test, Mann-Whitney U test and Chi-square for parametric, non-parametric continuous data, and categorical data respectively. Differences between groups with $p<0.05$ have statistical significance. Main outcome of re-intubation was reported using median and interquartile range (IQR). Risk factors were analyzed by multivariable logistic regression. Adjusted odds ratio (OR) were reported with 95% confidence interval (CI). Because length of ICU stay and hospital stay are continuous data, multivariable logistic regression is reported as adjusted coefficient.

Results

Among a total of 4,652 admissions there were 1,764 patients who were not intubated during ICU admission. The rest of 2,890 patients were intubated and were analyzed in the present study (Fig. 1). Extubation was considered in all 2,890 patients during admission. However, only 2,749 patients underwent successful extubation but 141 patients required re-intubation within 72 hours. Data were compared between successful extubation and re-intubation group (Table 2). In re-intubation group, there were three patients with data missing from 're-intubation' record forms. Therefore, only 138 patients in this group were detailed and analyzed in Table 3.

The overall incidence of re-intubation was 4.88% (ranging from 1.41 to 7.33) among nine hospitals (Table 1). Characteristics of patients in both groups were compared in Table 2. From the successful

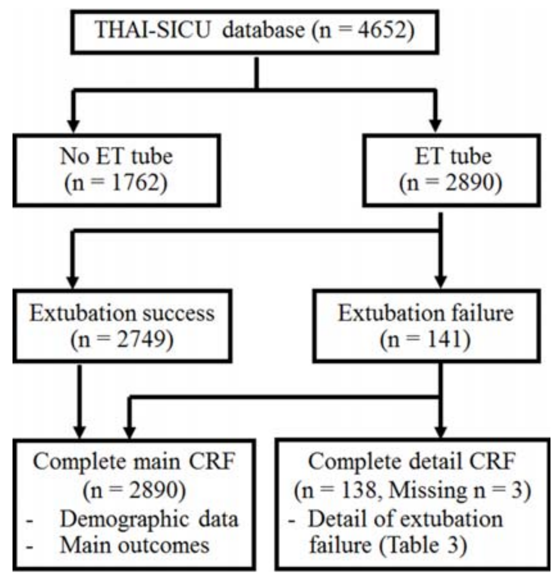

Fig. 1 Study flow and analysis.

extubation group the following characteristics were different from EF group with statistical significance: age (60.56 vs. 67.23 year); the presence of congestive heart failure (2.22 vs. 7.80%), vascular disease (4.95 vs. 9.22%), chronic obstructive pulmonary disease (COPD) (4.80 vs. 9.22%), emergency surgery (30.56 vs. 45.39%), higher SOFA score (3 vs. 4), higher APACHE II score (12 vs. 13), and concurrent administration of vasopressors, inotropes and sedative agents.

Patient characteristics in re-intubation group (n = 138) were detailed (Table 3). The cause of re-intubation was reported as respiratory failure from exhaustion (46.38%), inability to cough (26.81%), laryngeal edema (9.42%), heart failure (8.7%), and alteration of consciousness (7.97%). Type of respiratory support prior to extubation was identified as T-piece (46.38%), pressure support ventilation-PSV (35.51%), pressure control/volume control ventilation or other full support modes (13.04%) and SIMV (5.07%). Prior to planned extubation 18 cases (13.04%) had received steroids most of which was dexamethasone.

When EF had occurred non-invasive ventilation (NIV) was attempted in 19.57% of total cases (27/138) followed by re-intubation. According to the available data only 1 out of 138 cases was unsuccessful in re-intubation and required surgical airway. After re-intubation, 124 cases had improvement in oxygenation (89.85%). Only 9 cases (6.52%) had severe hypoxia and 3 cases had cardiac arrest. None had hypoxic encephalopathy.

Table 1. Incidence of extubation failure in THAI-SICU study

Site*	Number of all intubated patients	Number of extubation failure	Incidence (%)	ICU type**	ICU bed: total beds
SI	561	37	6.60	Closed	1:158
RA	242	5	2.07	Mandatory	1:112
CU	357	26	7.28	Mandatory	1:181
PMK	203	7	3.45	Mandatory	1:150
BMU	241	12	4.98	Elective	1:142
SWU	78	4	5.13	No	1:64
CMU	546	40	7.33	Closed	1:100
KKU	307	5	1.63	No	1:121
PSU	355	5	1.41	No	1:85
Overall	2,890	141	4.88		

* SI = Siriraj Hospital; RA = Ramathibodi Hospital; CU = King Chulalongkorn Memorial Hospital; PMK = Phra Mongkutklao Hospital; BMU = Vajira Hospital; SWU = Srinakharinwirot University; CMU = Chiang Mai University; KKU = Khon Kaen University; PSU = Prince of Songkla University

** Closed = run by fully responsible intensivists; Mandatory = intensivists do regular rounds but not as attendings; Elective = intensivists are consulted as per attending's request case by case; No = no intensivist coverage

Outcomes of re-intubation are described in Table 4. ICU mortality and 28-day mortality were not different between the 2 groups (14.66 vs. 14.89% and 19.83 vs. 20.57%, respectively, $p>0.05$). However, length of ICU stay and length of hospital stay were significantly longer in EF group (11 days, IQR 6-15 and 23 days, IQR 15-33) compare to successful extubation group (2 days, IQR 1-5 and 16 days, IQR 10-27).

Multivariable logistic regression analysis of risk factors and outcomes of EF is described in Table 5. Both risk factors and outcomes were adjusted by age, sex, underlying congestive heart failure, vascular diseases, COPD, type of surgery, APACHE II score, and SOFA score. The adjusted odds ratio was calculated for each risk factor and outcome of EF with adjusted coefficient applied to length of ICU stay and length of hospital stay. With 95% confidence interval, statistical significance was found in the following risk factors: age (1.02, 95% CI = 1.01-1.04), congestive heart failure (2.65, 95% CI = 1.31-5.40), emergency surgery (1.84, 95% CI = 1.29-2.63) and SOFA score (1.06, 95% CI = 1.00-1.12). Length of ICU stay and length of hospital stay had adjusted coefficient of 6.67 (95% CI = 5.68-7.65) and 3.54 (95% CI = -0.91-7.99) but the latter had no statistical significance.

Discussion

Although immediate extubation is favorable after completion of surgery[4,5], a large number of patients need postoperative supportive ventilation and remain intubated in the ICU. When patient condition is fulfilled, extubation is considered. However, the outcome of extubation is sometimes adversary. When re-intubation occurs within hours to several days after planned extubation[6], EF has occurred.

EF is not a rare complication. In the ICU setting, incidence of EF can be as high as 17%[7]. The mean incidence in the present study is 4.88%, ranging from 1.41 to 7.33%, which is not different from other studies (1.7-17.9%). However, there is no significant relationship between the ratios of ICU beds: total beds and the incidence of EF in each hospital. It is probably argued that a ratio of ICU beds: surgical beds would be more likely to be associated with the incidence of EF. With respect to the type of ICU and availability of intensivist, there are two hospitals (KKU and PSU) with lowest incidence of EF that runs without intensivist coverage. Without relevant data about extubation protocols used in each ICU, one of the possible explanations is that ICU without intensivist is run by attending surgeons. They are comfortable with the timing of extubation without concern about bed availability on the wait list. In contrast, intensivist-run ICUs would try to manage the demand against the available beds and that might compromise the extubation decision.

Patient characteristics difference between successful and EF group was similar to previous studies[8,9], for example, age, COPD, and arterial vascular disease. Gowardman[10] reported that higher 24-hour

Table 2. Patient characteristics

	Extubation success (n = 2,749)	Extubation failure (n = 141)	All (n = 2,890)	*p*-value
Age, year (SD)	60.56 (17.58)	67.23 (15.23)	60.89 (17.52)	<0.001
Male, n (%)	1,652 (60.09)	77 (54.61)	1,729 (59.83)	0.195
Comorbidity, n (%)				
Hypertension	1,198 (43.58)	69 (48.94)	1,267 (43.84)	0.211
Coronary artery diseases	201 (7.31)	15 (10.64)	216 (7.47)	0.143
Congestive heart failure	61 (2.22)	11 (7.80)	72 (2.49)	<0.001
Vascular disease	136 (4.95)	13 (9.22)	149 (5.16)	0.025
Stroke	152 (5.53)	5 (3.55)	157 (5.43)	0.311
Asthma	48 (1.75)	0 (0.00)	48 (1.66)	0.114
COPD	132 (4.80)	13 (9.22)	145 (5.02)	0.019
Diabetes mellitus	580 (21.10)	33 (23.40)	613 (21.21)	0.514
Chronic renal failure	241 (8.77)	18 (12.77)	259 (8.96)	0.105
Chest x-ray finding at admission, n (%)				
Normal	1,864 (70.45)	84 (62.22)	1,948 (70.05)	0.107
Local infiltration	370 (19.98)	26 (19.26)	396 (14.24)	
Bilateral infiltration	412 (15.57)	25 (18.52)	437 (15.71)	
Smoking status, n (%)				
Non-smoker	1,711 (62.24)	93 (65.96)	1,804 (62.42)	0.663
Current smoker	360 (13.10)	16 (11.35)	376 (13.01)	
Ex-smoker	678 (24.66)	32 (22.70)	710 (24.57)	
ASA classification, n (%)				
Class I	124 (6.11)	3 (2.91)	127 (5.95)	0.128
Class II	615 (30.28)	22 (21.36)	637 (29.85)	
Class III	932 (45.89)	60 (58.25)	992 (46.49)	
Class IV	310 (15.26)	17 (16.50)	327 (15.32)	
Class V	47 (2.31)	1 (0.97)	48 (2.25)	
Class VI	3 (0.15)	0 (0.00)	3 (0.14)	
Type of surgery, n (%)				
Emergency	840 (30.56)	64 (45.39)	904 (31.28)	<0.001
Elective	1,133 (41.21)	39 (27.66)	1,172 (40.55)	
Not defined	776 (28.23)	38 (26.95)	814 (28.17)	
Surgical site, n (%)				
Head and neck	188 (6.84)	9 (6.38)	197 (6.82)	0.834
Thoracic	158 (5.75)	7 (4.96)	165 (5.71)	0.696
Cesarean section	9 (0.33)	1 (0.71)	10 (0.35)	0.451
Upper abdomen	863 (31.39)	50 (35.46)	913 (31.59)	0.311
Lower abdomen	761 (27.68)	41 (29.08)	802 (27.75)	0.718
Spine	78 (2.84)	5 (3.55)	83 (2.87)	0.623
Peripheral vascular disease	53 (1.93)	2 (1.42)	55 (1.90)	0.666
Orthopedics	180 (6.55)	8 (5.67)	188 (6.51)	0.681
Severity of diseases [median (IQR)]				
SOFA score	3 (1-6)	4 (3-7)	3 (1-6)	<0.001
APACHE II	12 (8-18)	13 (10.5-19)	12 (8-18)	0.007
Receiving ICU medication, n (%)				
Vasopressor agents	932 (33.90)	77 (54.61)	1,009 (34.91)	<0.001
Inotropic agents	262 (9.53)	28 (19.86)	290 (10.03)	<0.001
Neuromuscular blocking agents	200 (7.28)	14 (9.93)	217 (7.40)	0.241
Sedative agents	865 (31.47)	87 (61.70)	952 (32.94)	<0.001
Analgesic agents	2,328 (84.69)	126 (89.36)	2,454 (84.91)	0.130

APACHE II score was associated with EF (18.0±7.0) when compared to non-EF group (15.3±7.4). Similarly, the APACHE II scores in the EF group and successful group in the present study were significantly different although the median (IQR) was lower [13 (10.5-19) vs. 12 (8-18)]. This could be due to scores that were recorded more frequently during ICU admission (day 0, 1, 2, 3, 7, 14, 21, 28 and ICU discharge day) and the value represented the median and IQR from the total scores recorded might be averaged down. It is noted that parameters in APACHE II overlap those of SOFA scores and it is why those parameters had statistically significant differences between groups, for example, age, emergency surgery, and COPD/ congestive heart failure (with poor gas exchange). Sedatives given in the ICU may lower the level of consciousness which is a strong predictor of EF[1,11].

Table 3. Detail of re-intubation

	n	(%)
Cause of re-intubation		
Respiratory failure from exhaustion	64	46.38
Inability to cough	37	26.81
Heart failure	12	8.70
Laryngeal edema	13	9.42
Alteration of consciousness	11	7.97
Other	25	18.12
Respiratory support before extubation		
T-piece	64	46.38
PSV	49	35.51
SIMV	7	5.07
PCV, VCV or full support mode	18	13.04
NIV before re-intubation	27	19.57
Re-intubation success		
Success of re-intubation	137	99.28
Not successful and need surgical airway	1	0.72
Immediate outcome after re-intubation		
Improved hypoxemia	124	89.85
Severe hypoxia	9	6.52
Cardiac arrest	3	2.17
Hypoxic encephalopathy	0	0.00
Surgical airway	1	0.72
Persistent exhaustion	1	0.72
Steroid receiving before extubation	18	11.59
Dexamethasone	16/18	88.89
Methylprednisolone	2/18	1.11

PSV = pressure support ventilation; SIMV = synchronous intermittent mandatory ventilation; PCV = pressure control ventilation; VCV = volume control ventilation; NIV = non-invasive ventilation

With regard to causes of EF, the top three on the list was similar to one study from Thailand[12] which were respiratory failure, inability to cough, and heart failure.

T-piece (46.38%) and PSV (35.51%) were most common spontaneous breathing trial (SBT) before extubation in the present study. Although SBT which is a common approach in weaning or extubation protocol was used, EF still occurred. Therefore, additional parameters must be considered to predict EF during SBT. These include respiratory rate: tidal volume ratio while being on automatic tube compensation mode (RVRATC)[13], heart rate[14], minute ventilation recovery time[15] and cough peak expiratory flow[16]. An extensive list of parameters to be considered before extubation was reported by Epstein[17].

Non-invasive ventilation (NIV) before re-intubation (nasal CPAP or NPPV) in patients with oxygen transfer deterioration is helpful in avoiding re-intubation[18,19]. It also reduces mortality, ICU/ hospital stay, and pulmonary infection. This is also evident in a meta-analysis[20] that NIV after extubation reduces rates of re-intubation, ICU/hospital stay, pneumonia, and hospital survival. Nearly 20% of EF patients in the present study had non-invasive ventilation (NIV) before re-intubation. This means 80% of EF patients were re-intubated immediately without trial of NIV. The availability of NIV equipment, the familiarity with its use and the severity of EF may preclude the use of NIV.

Administration of 40 mg methyl prednisolone

Table 4. Main outcomes of extubation failure

	Extubation success (n = 2,749)	Extubation failure (n = 141)	All (n = 2,890)	*p*-value
ICU mortality, n (%)	403 (14.66)	21 (14.89)	424 (14.67)	0.939
28 day mortality, n (%)	545 (19.83)	29 (20.57)	274 (19.86)	0.829
Length of ICU stay [median (IQR)]	2 (1-5)	11 (6-15)	3 (1-6)	<0.001
Length of hospital stay [median (IQR)]	16 (10-27)	23 (15-33)	16 (10-28)	<0.001

Table 5. Multivariable regression analysis of risk factors and outcomes of extubation failure

		Value	95% CI	*p*-value
Risk factor of re-intubation				
Age	Adjusted OR	1.02	1.01 to 1.04	<0.001
Female	Adjusted OR	1.21	0.85 to 1.74	0.281
Congestive heart failure	Adjusted OR	2.65	1.31 to 5.40	0.007
Vascular disease	Adjusted OR	1.64	0.88 to 3.04	0.118
COPD	Adjusted OR	1.54	0.81 to 2.95	0.190
Emergency surgery	Adjusted OR	1.84	1.29 to 2.63	0.001
APACHE II score	Adjusted OR	0.98	0.95 to 1.01	0.199
SOFA score	Adjusted OR	1.06	1.00 to 1.12	0.045
Outcome of re-intubation*				
ICU mortality	Adjusted OR	1.17	0.68 to 2.03	0.563
28 day mortality	Adjusted OR	1.07	0.67 to 1.72	0.776
Length of ICU stay	Adjusted Coef	6.67	5.68 to 7.65	<0.001
Length of hospital stay	Adjusted Coef	3.54	-0.91 to 7.99	0.119

*Adjusted by age, sex, underlying of congestive heart failure, vascular diseases, COPD, type of surgery, APACHE II score, SOFA score.
OR = Odds ratio; Coef = Coefficient; COPD = Chronic obstructive pulmonary disease; ICU = intensive care unit

4 hours prior to extubation could lead to lower incidence of post-extubation stridor and re-intubation when compared to placebo[21]. In the present study 88.41% of patients with EF did not receive steroids. Unfortunately, there was no data on whether steroids were administered in successful extubation group.

To avoid EF and its deleterious consequences, many protocols for weaning and extubation have been developed. Such protocol can be developed by multidisciplinary team with higher acceptance of implementation[7]. Unfortunately, the present study is observational in nature and details of extubation and weaning protocol is not recorded. Even without the data on protocol used, outcomes of EF in the present study were comparable with previous studies[9,12,22]. Length of ICU stay and hospital stay were significantly prolonged in EF group. Mortality, however, was not different between groups.

Risk factors associated with EF has been reported. Brown et al[1] demonstrated that in trauma patients EF was associated with spine fracture, intubation with airway reasons, Glasgow Coma Scale (GCS) at extubation and delirium tremens. The level of consciousness at the time of extubation is a strong predictor for EF in patients undergoing intracranial surgery[11]. EF also led to prolonged ICU and hospital stay, period of mechanical ventilation, pulmonary complications and higher rates of tracheostomy. In the present study, risk factors were identified. When compared between groups these risks strongly predicts EF. However, when adjusted odds ratios were calculated only advanced age, congestive heart failure, emergency surgery, SOFA score and length of ICU stay were statistically significant. Interestingly, EF was associated with a 6-fold longer stay in ICU as compared to 2-fold in the previous study[23].

Because of the observational methodology in nature, the present study primarily identified patient characteristic at risk of EF and its outcomes. Further study should focus on modifying these risks to minimize EF and to improve the outcomes. However, there were some limitations. The underlying cause of EF was unknown due to the lack of data about extubation protocols implemented in each ICU and the indications for intubation. The number of beds in surgical wards in each institution was also unknown. Therefore, it was not possible to demonstrate the ratio of ICU bed to surgical ward beds which would determine the scarcity of ICU bed availability. Unfortunately, the authors did not explore the details of 10 cases of EF from KKU and PSU. Otherwise, underlying reasons of lowest incidence of EF would be demonstrated.

Conclusion

Extubation failure or re-intubation within 72 hours after planned extubation is a serious complication in SICU. Overall incidence was 4.88% regardless of type of ICU or ICU bed: total bed ratio. Outcomes of EF included prolonged ICU and hospital length of stay. Adjusted odds ratio calculation suggested that age, congestive heart failure, emergency surgery, and SOFA score were independent risk factors. Patients with EF were at risk of 6-fold longer ICU stay. Understanding and modifying risk factors of EF will help reduce the incidence and improve the outcomes.

What is already known on this topic?

The incidence of EF is reported in the literature with variability due to EF definition. The study of EF in ICU has been conducted since 2002 but with limited number of EF patients. Therefore multivariate regression analysis of risk factors is unlikely. In addition, odds ratio calculation is not determined yet.

What this study adds?

Overall incidence of EF is congruent to published articles globally. Elaborated patient characteristic are identified and compared. Risk factors are identified. Adjusted odds ratio of certain risk factors indicates concerns before extubation.

Acknowledgements

The authors would like to thank nurse anesthetists at HRH Princess Maha Chakri Sirindhorn Medical Center for their collaborative effort to collect the data. The THAI-SICU study was supported by the Royal College of Anesthesiologists of Thailand, National Research Council of Thailand (NRCT), Mahidol University, Chulalongkorn University, Chiang Mai University, Khon Kaen University, Prince of Songkla University, Navamindradhiraj University, Phramongkutklao Hospital and Srinakharinwirot University. Data processing was performed by The Consortium Of Thai Medical Schools Research Network. The Publication fee was provided by the Medical Association of Thailand (Prasert Prasarttong-Osoth).

The THAI-SICU STUDY were listed

Suneerat Kongsayreepong, Onuma Chaiwat (Siriraj hospital, Mahidol University, Bangkok), Kaweesak Chittawatanarat, Tanyong Pipanmekaporn (Chiang Mai University, Chiang Mai) Sunthiiti Morakul (Ramathibodi Hospital, Bangkok), Thammasak Thawitsri, Somrat Charuluxananan (King Chulalongkorn Memorial Hospital, Bangkok), Petch Wacharasint, Pusit Fuengfoo (Phramongkutklao Hospital, Bangkok), Sunisa Chatmongkolchart, Osaree Akaraborworn (Prince of Songkla University, Songkhla), Chompunoot Pathonsamit, Sujaree Poopipatpab (Navamindradhiraj University, Vajira Hospital, Bangkok), Sarinya Chanthawong, Waraporn Chau-In (Khon Kaen University, Khon Kaen), Chaiyapruk Kusumaphanyo, Phakapan Buppha (Srinakharinwirot University, Nakhon Nayok).

Potential conflicts of interest

None.

References

1. Brown CV, Daigle JB, Foulkrod KH, Brouillette B, Clark A, Czysz C, et al. Risk factors associated with early reintubation in trauma patients: a prospective observational study. J Trauma 2011; 71: 37-41.
2. Perren A, Domenighetti G, Mauri S, Genini F, Vizzardi N. Protocol-directed weaning from mechanical ventilation: clinical outcome in patients randomized for a 30-min or 120-min trial with pressure support ventilation. Intensive Care Med 2002; 28: 1058-63.
3. Chittawatanarat K, Chaiwat O, Morakul S, Pipanmekaporn T, Thawitsri T, Wacharasint P, et al. A multi-center Thai university-based surgical intensive care units study (THAI-SICU study): methodology and ICU characteristics. J Med Assoc Thai 2014; 97 (Suppl 1): S45-54.
4. Almada CP, Martins FA, Tardelli MA, Amaral JL. Time of extubation and postoperative outcome after thoracotomy. Rev Assoc Med Bras 2007; 53: 209-12.
5. Rodriguez Blanco YF, Candiotti K, Gologorsky A, Tang F, Giquel J, Barron ME, et al. Factors which predict safe extubation in the operating room following cardiac surgery. J Card Surg 2012; 27: 275-80.
6. Thille AW, Cortes-Puch I, Esteban A. Weaning from the ventilator and extubation in ICU. Curr Opin Crit Care 2013; 19: 57-64.
7. Chan PK, Fischer S, Stewart TE, Hallett DC, Hynes-Gay P, Lapinsky SE, et al. Practising evidence-based medicine: the design and implementation of a multidisciplinary team-driven extubation protocol. Crit Care 2001; 5: 349-54.
8. Kulkarni AP, Agarwal V. Extubation failure in intensive care unit: predictors and management. Indian J Crit Care Med 2008; 12: 1-9.
9. Rady MY, Ryan T. Perioperative predictors of extubation failure and the effect on clinical outcome after cardiac surgery. Crit Care Med 1999; 27: 340-7.

10. Gowardman JR, Huntington D, Whiting J. The effect of extubation failure on outcome in a multidisciplinary Australian intensive care unit. Crit Care Resusc 2006; 8: 328-33.
11. Hayashi LY, Gazzotti MR, Vidotto MC, Jardim JR. Incidence, indication and complications of postoperative reintubation after elective intracranial surgery. Sao Paulo Med J 2013; 131: 158-65.
12. Toomtong P, Raksakietisak M, Vorakitpokatorn P. Clinical outcomes of failed extubation in a postoperative intensive care unit. J Med Assoc Thai 2002; 85 (Suppl 3): S987-92.
13. Cohen JD, Shapiro M, Grozovski E, Singer P. Automatic tube compensation-assisted respiratory rate to tidal volume ratio improves the prediction of weaning outcome. Chest 2002; 122: 980-4.
14. Dupont H, Le Port Y, Paugam-Burtz C, Mantz J, Desmonts M. Reintubation after planned extubation in surgical ICU patients: a case-control study. Intensive Care Med 2001; 27: 1875-80.
15. Martinez A, Seymour C, Nam M. Minute ventilation recovery time: a predictor of extubation outcome. Chest 2003; 123: 1214-21.
16. Gao XJ, Qin YZ. [A study of cough peak expiratory flow in predicting extubation outcome]. Zhongguo Wei Zhong Bing Ji Jiu Yi Xue 2009; 21: 390-3.
17. Epstein SK. Decision to extubate. Intensive Care Med 2002; 28: 535-46.
18. Boeken U, Schurr P, Kurt M, Feindt P, Lichtenberg A. Early reintubation after cardiac operations: impact of nasal continuous positive airway pressure (nCPAP) and noninvasive positive pressure ventilation (NPPV). Thorac Cardiovasc Surg 2010; 58: 398-402.
19. Kindgen-Milles D, Buhl R, Gabriel A, Bohner H, Muller E. Nasal continuous positive airway pressure: A method to avoid endotracheal reintubation in postoperative high-risk patients with severe nonhypercapnic oxygenation failure. Chest 2000; 117: 1106-11.
20. Glossop AJ, Shephard N, Bryden DC, Mills GH. Non-invasive ventilation for weaning, avoiding reintubation after extubation and in the postoperative period: a meta-analysis. Br J Anaesth 2012; 109: 305-14.
21. Cheng KC, Chen CM, Tan CK, Chen HM, Lu CL, Zhang H. Methylprednisolone reduces the rates of postextubation stridor and reintubation associated with attenuated cytokine responses in critically ill patients. Minerva Anestesiol 2011; 77: 503-9.
22. Rothaar RC, Epstein SK. Extubation failure: magnitude of the problem, impact on outcomes, and prevention. Curr Opin Crit Care 2003; 9: 59-66.
23. Menon N, Joffe AM, Deem S, Yanez ND, Grabinsky A, Dagal AH, et al. Occurrence and complications of tracheal reintubation in critically ill adults. Respir Care 2012; 57: 1555-63.

ผลลัพธ์และปัจจัยเสี่ยงของการถอดท่อหายใจไม่สำเร็จ: การศึกษาแบบสหสถาบันในหออภิบาลผู้ป่วยหนักศัลยกรรม

ผกาพรรณ บุปผา, ชัยพฤกษ์ กุสุมาพรรณโญ, กวีศักดิ์ จิตตวัฒนรัตน์, กลุ่มศึกษา THAI-SICU

วัตถุประสงค์: *เพื่อศึกษาผลลัพธ์และปัจจัยเสี่ยงที่มีผลต่อการถอดท่อหายใจไม่สำเร็จ (EF) ในผู้ป่วยที่รับไว้ในหอผู้ป่วยหนักศัลยกรรม*

วัสดุและวิธีการ: *เก็บข้อมูลจากผู้ป่วยที่รับไว้ในหอผู้ป่วยหนักศัลยกรรมในโรงพยาบาลมหาวิทยาลัย 9 แห่ง ในช่วงเดือนเมษายน พ.ศ. 2554 ถึงเดือนมกราคม พ.ศ. 2556 ข้อมูลที่เก็บคือ ข้อมูลส่วนตัวผู้ป่วย ข้อมูลแรกรับ ข้อมูลรายวัน ข้อมูลโภชนาการ คะแนน APACHE II และข้อมูลการจำหน่ายผู้ป่วย เกณฑ์การคัดออกคือ ผู้ป่วยศัลยกรรมประสาท ได้รับบาดเจ็บหลายระบบ ผู้ป่วยโรคทางหัวใจ หลอดเลือดและทรวงอก ผู้ป่วยอายุน้อยกว่า 15 ปี และผู้ป่วยที่ไม่ให้ความยินยอม เก็บข้อมูลทุกวันจนกว่าจะจำหน่ายผู้ป่วยหรือเก็บจนครบ 28 วัน แล้วหาอัตราตาย ภาวะแทรกซ้อนหรือเหตุการณ์ที่ไม่พึงประสงค์ที่เกิดขึ้น ซึ่งจะเก็บข้อมูลรายละเอียดในแบบกรอกข้อมูลแยกต่างหากเพิ่มเติม*

ผลการศึกษา: *ผู้ป่วยที่ศึกษามีทั้งหมด 4,652 ราย เป็นผู้ป่วยที่ต้องใส่ท่อหายใจ 2,890 ราย ในจำนวนนี้มี 2,749 รายที่สามารถถอดท่อหายใจได้สำเร็จ ที่เหลืออีก 141 รายมีภาวะ EF อุบัติการณ์ของ EF ในภาพรวมทั้ง 9 โรงพยาบาลคิดเป็นร้อยละ 4.88 (ตั้งแต่ 1.41 ถึง 7.33) เปรียบเทียบผู้ป่วยในกลุ่มที่ถอดท่อสำเร็จ กับกลุ่มที่มีภาวะ EF พบว่า กลุ่ม EF มีอายุมากกว่า มีภาวะหัวใจวาย โรคหลอดเลือด โรคถุงลมโป่งพองมีการผ่าตัดแบบฉุกเฉิน มีคะแนน APACHE II และ SOFA ที่แย่กว่า ได้รับยาตีบหลอดเลือด ยากระตุ้นการบีบตัวของหัวใจ ยากล่อมประสาทมากกว่าอย่างมีนัยสำคัญทางสถิติ ($p<0.05$) สาเหตุที่สำคัญ 3 ลำดับแรกของ EF คือ ภาวะหายใจล้มเหลว ไม่สามารถไอเองได้ และกล่องเสียงบวม ผลลัพธ์ของ EF คือผู้ป่วยนอนไอซียูนานขึ้นเมื่อเทียบกับกลุ่มถอดท่อสำเร็จ (11 days IQR 6-15 vs. 2 days IQR 1-5) และนอนโรงพยาบาลนานขึ้น (23 days IQR 15-33 vs. 16 days IQR 10-27) อย่างมีนัยสำคัญ ($p<0.05$) สำหรับกลุ่ม EF adjusted odds ratio สำหรับการนอนนานในไอซียูเป็น 6 เท่าของกลุ่มถอดท่อสำเร็จ*

สรุป: *EF เป็นภาวะที่มีผลกระทบต่อผลลัพธ์ของการนอนไอซียู ทำให้วันนอนในไอซียูนานขึ้น และนอนโรงพยาบาลนานขึ้น การค้นหาปัจจัยเสี่ยงของ EF จะช่วยลดอุบัติการณ์และช่วยให้ผลลัพธ์ของการนอนไอซียูออกมาดีขึ้น Adjusted odds ratio ได้แก่ อายุมาก ภาวะหัวใจวาย การผ่าตัดแบบฉุกเฉินและ SOFA score ที่แย่*